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Vertebral Variation with Size in *Clevelandia ios*

By Charles R. Clothier

WHILE doing some work with the vertebrae of fishes, the author was presented with a group of specimens collected by Dr. Carl Hubbs. In this group were ten individuals of *Clevelandia ios*, a small goby living on the mud flats of bays and estuaries of California.

The standard body length to the nearest half millimeter of each of these specimens is 13.0, 16.0, 16.5, 19.5, 26.5, 28.0, 31.5, 33.0, and 33.0 mm. respectively. Barnhart (1936, Marine Fishes of Southern California: 83) records the maximum length of *Clevelandia ios* to be 2 inches (51 mm.).

The specimens were cleared and stained with alizarin (Hollister, Zoologica, vol. 12, no. 10: 89–101) and in subsequent examination it was noted that the vertebrae of the larger size fish differed from the vertebrae of the smaller sizes to a degree that caused the author to wonder if he were not looking at several species of fish instead of one. However, they were checked a second time and all were positively identified as *Clevelandia ios*.

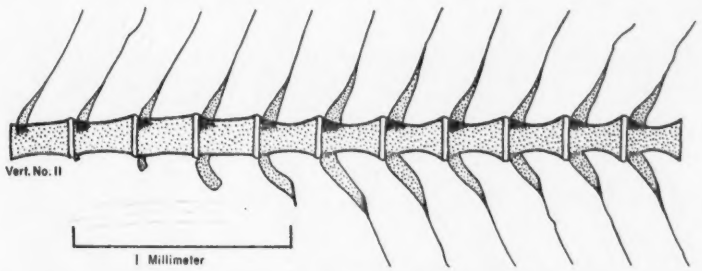


Fig. 1. Vertebrae 11 to 21 of a specimen of 13.0 mm. body length.

It is not unusual to find the vertebrae of fish undergoing modification for a few days after hatching. But it is unusual to find a species in which this modification is carried through from hatching to practically adult sizes.[1]

For purposes of illustrating the change, four fish were selected of the following sizes:—13.0, 16.5, 19.5, and 26.5 mm. At this last size the modification is almost complete, so the largest fish, one of the 33.0 mm. fish, is also illustrated to show that it differs only in minor detail from the 26.5 mm. fish. These five fish were photographed, and the drawings (Figs. 1 to 5) reproduced herewith were traced from enlargements of the photographs. Figures 6A to E are diagrammatic sketches of the first haemal arch of each of the five specimens.

Figure 1 illustrates the 13.0 mm. fish. The neuropophyses supporting the neural spine are very simple and occur on the anterior end of each centrum.

1 After clearing and staining, the gonads could not be seen. Consequently the size at maturity could not be accurately ascertained. However, I feel that a fish which is one half of the maximum recorded size could be considered as a mature fish.

The first haemal arch is on the second vertebra in front of the first haemal spine and is narrow and pointed (Fig. 6A).

The 16.5 mm. fish is shown in Figure 2. The neuropophyses have become heavier, and a few of them have started to grow points on the anterior edge.

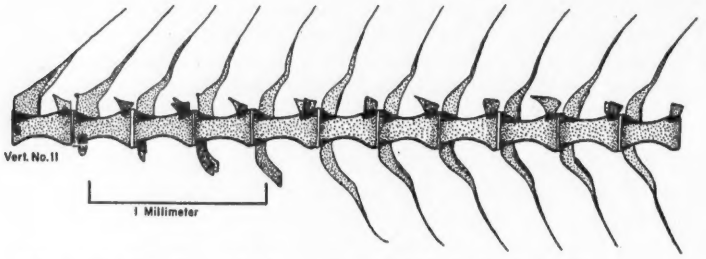


Fig. 2. Vertebrae 11 to 21 of a specimen of 16.5 mm. body length.

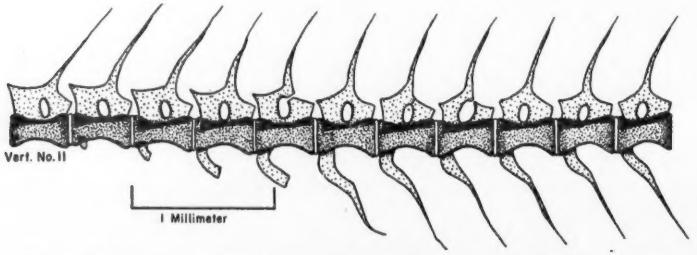


Fig. 3. Vertebrae 11 to 21 of a specimen of 19.5 mm. body length.

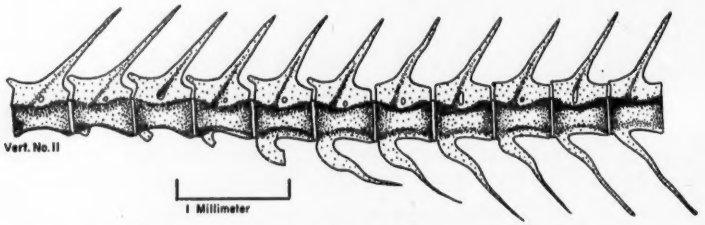


Fig. 4. Vertebrae 11 to 21 of a specimen of 26.5 mm. body length.

Small wings of bone have originated from the posterior end of each centrum and grown towards the neuropophyses. The first haemal arch is still on the second vertebra in front of the first haemal spine, but its shape has radically changed from a narrow pointed arch to one that is broad and square ended (Fig. 6B).

Figure 3 shows the 19.5 mm. fish. A very pronounced sharp point has developed on the anterior edge of each neuropophysis and the posterior edge has fused with the wings coming up from the posterior end of the centrum.

This junction, leaving a large hole, has occurred on nearly all of the vertebrae. The bridge of bone which formed the first haemal arch has been absorbed, leaving the haemopophyses open, and what was formerly the second haemal arch now becomes the first and occurs immediately in front of the first haemal spine. Its shape is the same but the haemopophyses are heavier (Fig. 6C).

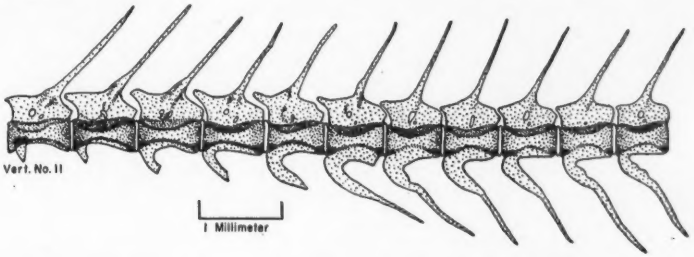


Fig. 5. Vertebrae 11 to 21 of a specimen of 33.0 mm. body length.

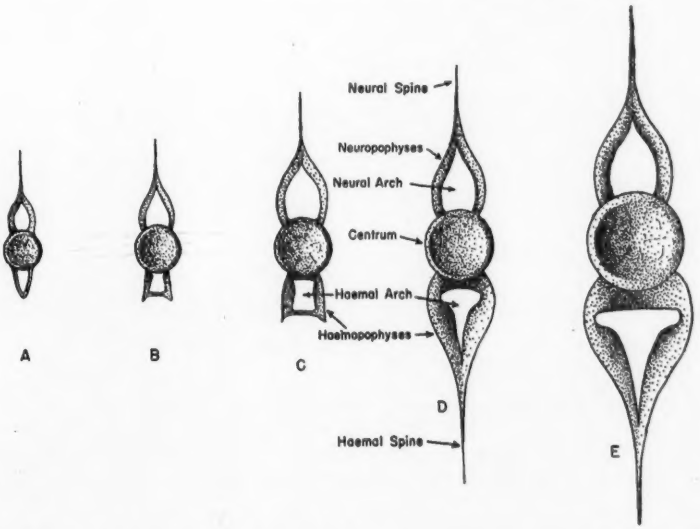


Fig. 6. Showing the variation of the first haemal arch for the five specimens. A is the 13.0 mm. fish. B is the 16.5 mm. fish. C is the 19.5 mm. fish. D is the 26.5 mm. fish. E is the 33.0 mm. fish.

Figure 4 indicates the development in the 26.5 mm. fish. The neuropophyses have now practically completed their growth and the large hole has been reduced to a very small hole. The neural spines have become very much heavier. The bridges of bone forming the haemal arches have been absorbed on all vertebrae in front of the first haemal spine and the first

haemal arch and the first haemal spine now occur on the same vertebrae (Fig. 6D).

Figure 5 shows the 33.0 mm. specimen, which is similar to the 26.5 mm. specimen in all major points. The first haemal arch and the first haemal spine still occur on the same vertebrae (Fig. 6E).

Examination of similar size ranges in *Ilypnus gilberti* and *Quietula y-cauda,* two closely related species, has shown a similar modification of the vertebrae though to a much less degree than is here shown for *Clevelandia ios.*

Bureau of Marine Fisheries, California Division of Fish and Game, Terminal Island, California.

A New Species of *Gyrinomimus* from the Gulf of Mexico

By Albert Eide Parr [1]

THE genus *Gyrinomimus* Parr [2] was previously only known from one single species, *G. myersi* Parr. The species here described as *G. simplex* differs from *G. myersi* in the following respects. The teeth in the jaws and the palate are arranged in long, extremely regular and continuous series, differing sharply from the complicated pattern found in *G. myersi* (see Parr, *op. cit.:* 31, fig. 9). The head of *G. simplex* is smaller, about 28 as compared with 32 per cent of the standard length. This difference is more conspicuous and significant than the difference in percentage ratios would indicate, and can perhaps be visualized more clearly by saying that the length of the head in *G. myersi* is very nearly one-third of the standard length, while the head of *G. simplex* is contained about 3⅔ times in the standard length of this species. The long, pointed flaps covering the lateral line pores especially in the caudal region of *G. myersi* are not found in *G. simplex.*

1 American Museum of Natural History and Bingham Oceanographic Laboratory.
2 Bull. Bingham Oceanogr. Coll. 4, Art. 6, 1934: 29.

A-C: ***Gyrinomimus simplex:*** **(A) dorsal view, (B) lateral view, (C) posterior part of lateral line. D:** ***Gyrinomimus myersi,*** **posterior part of lateral line.**

UNIV. OF MICH.

Among minor differences one might mention that the base of anal fin extends backward slightly, but distinctly beyond the base of dorsal fin in *G. simplex,* while the dorsal extends slightly, but distinctly beyond the anal in *G. myersi.* The pectoral fins are smaller, and their distance from the snout is slightly greater than the length of the head in *G. simplex,* and distinctly shorter than the length of the head in *G. myersi,* in which species the pectorals are thus inserted below (but not underneath) the posterior part of the gillcover.

Gyrinomimus ***simplex,*** new species

Length without caudal fin 66 mm. Proportions in per cent of this measurement: Lenth of head 28; length of maxillary 26; length of lower jaw 24; interocular width 13; eye about 1.5; interorbital width (skull) 12; snout to eye 10.5. Greatest external width between rami of lower jaw 16; width between tops of gillslits 9-10; snout to top of gillslit 19-20; snout to pectorals 30; length of pectorals 6; snout to origin of dorsal fin 71; origin of dorsal to base of caudal fin 30; base of dorsal fin 14.5; snout to origin of anal fin 72; base of anal fin 15. Greatest depth 18; depth at origin of dorsal fin (between distal ends of dorsal and anal pterygiophores) 12; least depth of caudal peduncle 4; width of caudal fin base 8; length of longest caudal fin-rays 14; longest anal rays 13-14; longest dorsal rays 13.

D.16½. A. 17½. P. 18. 14 main rays in caudal fin.

Gills 3½, a very small opening behind the third. Opening behind second and third gill arches also restricted to lower limbs, the upper limbs being joined by membrane.

One moderate pore in the lateral line immediately behind the top of the gill opening, followed by 15 very large pores. Pores on trunk of simple, rounded outline. Some of the pores on the tail have a triangular shape with a slight backward curvature of their anterior rim, but without any approach to the development of an extended, crested [3] flap covering, and reaching beyond the opening as in *G. myersi* Parr (see Plate I).

Dentition on all bones increases in sizes towards the inner row (posterior row on vomer). Upper jaw with 3 extremely regular series extending to the end of the maxillary. Inner series with ab. 120 teeth. Vomer with 2 transverse series, the posterior with ab. 9 teeth. Palatine with 3 series, the outer smaller and shorter, the inner with ab. 14 teeth. Pterygoid with a long inner series, and two incomplete outer series of smaller teeth. Lower jaw with 4 regular front series in front, the outer series of very minute teeth extends only about halfway to the end, the second series about two-thirds of the way, and the two inner series, which are extremely regular, extend all the way to the end of the dentary bone.

Type specimen No. 1218, Bingham Oceanographic Collection. Northwestern Gulf of Mexico. 26°00'N*.93°32'W. Atlantis station 2853, two-meter net in about 1200 meters depth. Bottom depth 1525-1430 fathoms.

American Museum of Natural History, New York, New York.

[3] A soft, horizontal, dermal keel extends along the middle of each flap on the caudal portion of *G. myersi,* and continues forward towards the next opening as a low, but well marked ridge on the lateral line tube.

Observations on the Comparative Ecology and Life History of Two Sea Robins, *Prionotus carolinus* and *Prionotus evolans strigatus* [1]

By Nelson Marshall

Introduction

TWO main incentives underlie this study. One stems from the desirability of learning more about marine food resources, especially since recent food shortages have made us more conscious of hitherto little used palatable fishes such as these sea robins. Included in this paper are data on weight-length relationships, abundance of size groups, relative abundance and other pertinent life history facts concerning *Prionotus carolinus* and *Prionotus evolans strigatus*. With such records, taken when these fish are not subject to an intensive fishery, the biologist will be able to make more intelligent analyses of the effects of fishing effort, if and when these species are taken in large numbers. Such an approach to possible fisheries problems of the future, recommended by many far-sighted biologists, is impractical unless research efforts are concentrated on those species which show some likelihood of utilization. The marketing of these sea robins has never been great,[2] many simply being used as bait when taken, but should these two species once meet with favor on the market, they could be taken in great numbers as an outstanding element (now being discarded as trash) of the pound net and inshore trawler catches. The enthusiastic recommendations of many who have tasted sea robins make it seem probable that trends toward broadening our current limited marketing of sea foods will encourage the utilization of this unexploited resource.

Another incentive issues from the desire to compare two such similar species inhabiting the same region. These two fishes, *Prionotus carolinus* and *Prionotus evolans strigatus*, are abundant during spring, summer, and early fall months in coastal waters off southern New England and the middle Atlantic states, no other triglids being common to this region. Their distribution, discussed by Jordan and Evermann (1898), Bigelow and Welsh (1925), Nichols and Breder (1927), Hildebrand and Schroeder (1928), and others, is such that they are found only in small numbers to the north of Cape Cod and extend southward as far as the coastal waters of South Carolina, the population of *P. evolans* off the Carolina coasts being referred to as

1 Contribution No. 341 from the Woods Hole Oceanographic Institution.

2 Market statistics on sea robins [*P. carolinus* and *P. evolans strigatus*] have been made available through the courtesy of A. W. Anderson of the U.S. Fish and Wildlife Service. The total sold annually over a period of twelve years have been:

1931	234,417 lbs.	1938	461,000 lbs.
1932	148,466 lbs.	1939	404,400 lbs.
1933	132,040 lbs.	1940	314,500 lbs.
1937	254,900 lbs.	1942	262,400 lbs.

Records are incomplete for the years omitted and have not as yet been compiled for the years subsequent to 1942. The following list of landings by vessels at New York City suggests a recent increase in marketing these species:

1938	6,005 lbs.	1942	1,495 lbs.
1939	19,475 lbs.	1943	5,035 lbs.
1940	14,615 lbs.	1944	28,315 lbs.
1941	10,850 lbs.		

a distinct subspecies, *P. evolans evolans*.[3]

To distinguish between these two species of sea robins of the New England and middle Atlantic coastal waters the following characters may be used:

P. carolinus

Pectoral fin reaches back to about sixth ray of second dorsal
Margin of caudal fin concave
Body and fins nearly plain except for some dark mottlings, chin usually dark

P. evolans strigatus

Pectoral fin reaches back to ninth or tenth ray of second dorsal
Margin of caudal fin almost straight
Two dark longitudinal stripes conspicuous along each side of body
General background color modified by orange tinge, particularly toward ventral surface and on pectoral fins

Common names applied to these species are important in introducing this study. Both are commonly referred to simply as sea robins, for few fishermen, commercial or otherwise, bother to differentiate between them. The Committee on the Common and Scientific Names of Fishes of the American Fisheries Society has settled on the following (as learned through correspondence with committee chairman Walter H. Chute in 1944):

Prionotus carolinus—Common sea robin

Prionotus strigatus [*P. evolans strigatus*]—Northern striped sea robin. The latter form is also commonly spoken of as the red (sea) robin and even as the cock or male robin on the erroneous assumption that it is the male and *P. carolinus* is the female of the same species.

Seasonal Occurrence in Southern New England Waters

With respect to their seasonal distribution *Prionotus carolinus* and *P. evolans strigatus*, like many other species of the region, are common along southern New England and Long Island shores during the warmer spring and summer months but leave this vicinity during the fall. Bigelow and Welsh (1925) state that *P. carolinus* leaves the southern New England coast in October and reappears in late April or May. This is confirmed and also shown to apply to *P. evolans strigatus* by records kept by the Bingham Oceanographic Laboratory in catch analyses that involved taking monthly trips on a flounder dragger fishing near Block Island, Rhode Island. In this sampling the first catch of *P. carolinus* in 1943 was from the trip made April 22; in 1944 from the trip on May 18. The first catch of *P. evolans strigatus* in 1943 was from the trip on May 11, and in 1944 from the trip on May 18. The last catch of *P. carolinus* during the 1943 and 1944 seasons was on the trips of October 31 and October 26 respectively; while the last catch of *P. evolans strigatus* was on September 21 in 1943, and October 26 in 1944. Temperature records obtained from lightships stationed in the shallow coastal waters off southern New England have been collected and summarized by Parr (1933) and from these it is seen that *Prionotus* is entering the region when the water temperatures range slightly above 40° F., is leaving at temperatures a little below 60° F.

[3] Jordan and Hughes (1887) suggested that the fish from northern localities, described as *P. strigatus*, and the closely related populations from southern localities, described as *P. evolans*, might be subspecifically related. Without comment Fowler (1906) put this suggestion into practice by referring to *P. evolans strigatus* in his "Fishes of New Jersey". Though the adoption of this nomenclature has been widespread, for example by Breder (1929), it has not been universally accepted and the true relationships of these populations have not been carefully studied.

The arrival of these species in the spring results in their occurrence in very large numbers in the pound nets. Norman G. Benson, who operates a pound net in Lambert's Cove, Vineyard Sound, Massachusetts, sent me the following note in May, 1944: "I put in trap the 29th of April. First haul May 1st—about 30 bbls. of robins [undoubtedly the majority were *P. carolinus*] which kept up for about 10 days." This quotation typifies the experience that pound and trap net operators have during this season not only with sea robins but with other species having a similar seasonal distribution.

The above mentioned trawler analyses of the Bingham Oceanographic Laboratory, which effectively date the beginning and end of seasonal inshore abundance of *P. carolinus* and *P. evolans strigatus* in southern New England, fail to show either species in any numbers during midsummer months. But the hauls studied were taken in about 18 fathoms while the reports of commercial fishermen and my own experience dragging in less than 10 fathoms in the Woods Hole area clearly demonstrate their continued abundance in shallower waters during this period.

The year around presence of *P. carolinus* in Chesapeake Bay described by Hildebrand and Schroeder (1928) is quite different from its seasonal distribution in New England. Chesapeake Bay waters are shallow and 23 fathoms is the greatest depth from which *P. carolinus* was recorded by these authors. Using temperature records from the tide station at Solomon Island, Maryland, a mid-bay station at the mouth of the Patuxent River, it is seen that the mean February (coldest month) water temperature from the years 1938 through 1942 was 38° F; consequently there is little doubt that in these shallow waters *P. carolinus* are exposed to lower temperatures than are prevalent in the southern New England coastal waters at the time of their departure. In discussing this matter, Mr. Schroeder has suggested that fish of this sort may be somewhat passive in their migration tendencies and thus might not undertake the long range travel necessary to leave the Chesapeake Bay waters.

Relative Abundance

Available information from which a concept of relative abundance might be developed comes from two chief sources, commercial pound net catches and catch records from commercial and research otter trawl operations.

Repeated sampling from June 11 through September 6, 1943, of the catch of five pound nets located in Buzzards Bay and Vineyard Sound, Massachusetts, yielded a count of 659 *P. carolinus* to 262 *P. evolans strigatus*, or a ratio of 2.5:1. These data, though not extensive, are in general agreement with relative catches as described by commercial pound net fishermen with years of experience. The somewhat greater numbers of *P. carolinus* can be regarded, therefore, as the general trend for pound net catches provided it is realized that there are times and places when such a ratio will be markedly upset. For example, on July 23, 1943, fishermen who had hauled five pound nets off Fire Island Inlet, Long Island, brought in for commercial sale only 94 *P. carolinus* to 323 *P. evolans strigatus*, a ratio of 1:3.4, which is only partially explained on the basis that the latter species reaches commercial size at an earlier age (see section on age and rate of growth).

In marked contrast to the catches of these five pound nets, a commercial dragger operating an otter trawl off Fire Island on the same date got a much larger catch of *Prionotus* in a ratio of 19 *P. carolinus* to 1 *P. evolans strigatus*. A similar contrast is noted when comparing the catches of two pound nets located in Menemsha Bight, Vineyard Sound, Massachusetts, on July 28, 1943, with otter trawl catches (using the fine meshed shrimp trawl described below) made in the same region August 2, 1943. The former yielded 81 *P. carolinus* to 67 *P. evolans strigatus*, or a ratio of 1.2:1; the latter yielded 94 *P. carolinus* but not a single *P. evolans strigatus* although trawling operations were carried out in all parts of the Bight, including areas in the immediate vicinity of pound nets. This comparative scarcity of *P. evolans strigatus* in otter trawl catches has been established by many additional records in 1943 and 1944. It also agrees with the accounts of fishermen who have been using this type of gear.[4]

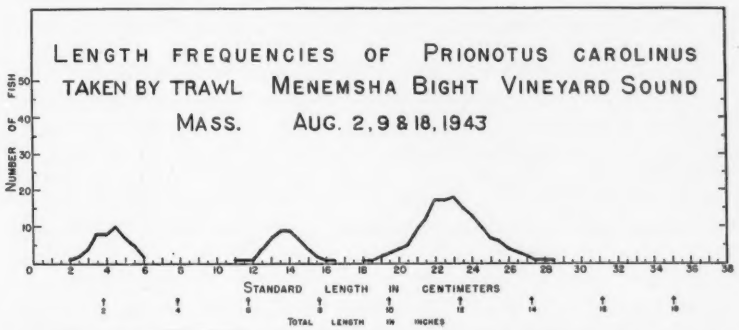

LENGTH FREQUENCIES OF PRIONOTUS CAROLINUS
TAKEN BY TRAWL MENEMSHA BIGHT VINEYARD SOUND
MASS. AUG. 2, 9 & 18, 1943
NUMBER OF FISH
STANDARD LENGTH IN CENTIMETERS
TOTAL LENGTH IN INCHES

Fig. 1. Length–frequency distribution of *Prionotus carolinus* taken by shrimp trawl in less than 12 fathoms in Menemsha Bight, Vineyard Sound, Mass., August 2, 9, and 18, 1943. Data smoothed by threes except where smoothing would eliminate the record of a single specimen of a given length.

An interpretation of the contrast in species abundance between pound net and otter trawl catches issues from a consideration of their respective modes of operation. The pound net is limited to the shallow water in which it must be set and depends on the movement of fish along the shore in such a way they will be guided into the heart and pound by the leader. Owing possibly to the large mesh of the gear (that of the pound being about 2½ inches stretched measure with the rest proportionately larger), some of the younger, smaller fish are not taken, a factor which might tend to exaggerate

4 The sex ratio of *P. carolinus*, judged from sampling records summarized in the following table, is approximately 1 to 1 and seems to be the same in pound nets and trawl catches.

	Males	Females
Pound net catches Woods Hole area 1943	260	280
Otter trawl catches		
Woods Hole area 1943	79	64
Woods Hole area 1944	77	94
Off Stonington, Conn. 1943	146	163
Totals	562	601

Though the small numbers of *P. evolans strigatus* taken by trawl has resulted in limiting available sex ratio data to pound net sampling, it seems safe to infer that the 109 ♂♂ to 134 ♀♀ of this species taken in pound nets in the Woods Hole area in 1943 is also indicative of a ratio close to 1 to 1.

the abundance of the faster growing *P. evolans strigatus* (see section on age and rate of growth).

The otter trawl can operate quite independently of depth and proximity to shore. To be sure, it can only be used on relatively smooth bottom but there is little reason to expect this might effect the catches of these two species of *Prionotus,* both of which are fish of sand and mud bottoms. Certainly this limitation does not explain the above mentioned differences between pound net and trawl catches in Menemsha Bight where the latter gear was operated in the immediate vicinity of the pound net.

Being towed from a boat, the trawl operates without depending on the movements of the fish caught but escape from this gear may to some extent vary with the degree of activity of the species. The escape factor is probably small when a net with a good overhang is handled properly and of little consequence in modifying the relative catches of two species like these sea robins which are known from food habit studies (see section on food habits) and aquarium observations [5] to have the same bottom tending habits and apparently the same reaction to the chain line of a trawl. The mesh of a commercial otter trawl such as used on the New England coastal area is about 4 inches (stretched measure) and thus the faster growing *P. evolans strigatus* might be more subject to catch. The shrimp trawl with its fine mesh (1½ inches stretched measure) proved very effective in catching fish of small size as well as larger ones and, accordingly, was adopted for research purposes.

Considering these points which relate to mode of operation, my interpretation is that pound net catches do not constitute a good index of relative abundance. The more even ratios of *P. carolinus* to *P. evolans strigatus* in pound nets as contrasted with the trawl catches, show a greater tendency for the latter species either to frequent or to move about in shallow water within a couple of hundred yards of the shoreline; perhaps its tendencies are greater in both respects.

On the other hand trawler catches, if extensive enough, if applied to species living in comparatively rockless areas where a trawl can operate effectively, and if applied to species with similar bottom tending habits, offer a better index of relative abundance. Thus it is practical to summarize the available trawler catch records of *Prionotus* as a key to relative numbers. The catch from Fire Island was adequately sampled as previously mentioned

[5] A miniature imitation trawl chain line was hauled across the bottom of an aquarium containing small specimens (averaging about 5.0 cm. standard length) of both species. No difference in their reaction to the line was detected. Further aquarium observations on the small, also on larger specimens, failed to reveal species behavior differences but demonstrated the following features common to *P. carolinus* and *P. evolans strigatus*:

When extended, the large pectoral fins, often referred to as "wings," tend to volplane their bodies slowly downward through the water as described by Breder (1926).

The pectorals tend to hold the fish tight to the bottom as currents passing backward along the body strike the oblique fin surfaces. The currents resulting from opercular action tend to produce the same effect and thus there is little or no necessity for fin motion to counteract the forward thrusts from these currents.

The pectoral fins, held close to the sides of the body when the fish is progressing through the water at a relatively fast pace, effectively brake the forward motion when extended.

The large pectoral fins are not used in vaulting through the air. The above notes show that they are adapted to functions of a distinctly different sort.

The small sea robins observed had a jumping ability sufficient to clear the 4 cm. leap over the aquarium edge. The smallest measured *P. carolinus* known to leap over this barrier was 5.5 cm. standard length, the smallest measured *P. evolans strigatus* was 3.4 cm. standard length.

The three pairs of pectoral feelers (modified anterior rays of the pectoral fin), shown by Morrill (1895) to be richly supplied with touch receptors and to be used in searching for food, play no active part in locomotion.

and ten hauls made with a shrimp trawl on two trips to Menemsha Bight in 1944 were completely counted. The data are greatly limited but the approximate 50 *P. carolinus* to 1 *P. evolans strigatus* ratio that is obtained is in general accord with the many less perfectly sampled trawler records available as well as with the accounts given by experienced fishermen. The value of this ratio lies in the fact that it offsets the less accurate impression received from pound net catches and, crude as it is, it is better than vague descriptive terms.

Spawning

In an effort to establish the time of spawning, constant attention has been directed to the ovarian condition of the sea robins collected. With respect to *Prionotus carolinus* it can be said that ripe eggs, either in fresh condition or of the proper size in preserved ovaries (see description of eggs below), have been recorded from specimens taken from June 24 through August 9 in 1943, and from July 7 through July 28 in the lesser collections of 1944. At earlier and later dates the eggs were smaller, the largest eggs from specimens collected May 11 and September 12, 1943, being by actual measurement, half the size of mature eggs. To this we may add the opinion of Kuntz and Radcliffe (1918) who state: "This species spawns in June, July and early August. Fish ripe for stripping were taken in small numbers during the first half of July. Eggs were abundant in the plankton throughout July and were taken in small numbers as late as August 24." C. M. Breder, Jr., has generously permitted me to refer to certain unpublished notes dealing with studies he made in Atlantic City, New Jersey, in 1920. In these it is recorded that the first ripe *P. carolinus* were taken on August 19, a late date which he recognizes with the suggestion that it may be related to "the backward season." Perlmutter (1939) found eggs he identified as *P. carolinus* from May 12 through August 8 along the shores of Long Island and states that this species spawns from May through August in water from 55° F. to 76° F. In summary the above information establishes mid-June through early August as the spawning period in southern New England and vicinity and suggests an even longer period with possible variations as the seasons vary.

Ripe eggs, either in fresh condition or of the proper size in preserved specimens (see description of eggs below), have been recorded from ovaries of *P. evolans strigatus* taken as early as July 9 and as late as July 28, 1943. The only ripe fish noted in the lesser 1944 collections was one taken in Menemsha Bight, July 28. Measurement records show several fish with nearly ripe eggs taken during the last two weeks of June both years and, since records relating to degree of maturity (as judged by size) show many similarities between this species and *P. carolinus*, it may be that the discrepancy between the data for late June is the result of inadequate sampling. Summarizing its breeding season from the above data it may be said that *P. evolans strigatus* breeds through the month of July and perhaps in late June and early August, with possible changes as the seasons vary.

The measurement records show, also, that *P. carolinus* of about 14 cm. standard length and *P. evolans strigatus* of about 18 cm. standard length (both one-year-olds according to section on age and rate of growth) may

produce ripe eggs. As would be expected of these small fish, the ovaries are small and the eggs comparatively few in number.

The appearance of the ovaries, which are similar in these two species, contributes to an understanding of their spawning. Variability of egg size and development is conspicuous throughout. The largest eggs, whether ripe or partially so, are not grouped but are scattered amongst less developed eggs of diverse sizes. Correlated with this is the fact that few eggs are ripe at any one time and the breeding season is somewhat prolonged.

Another feature is the diversity of ovarian condition noted when comparing individuals at any given date. For example, ovaries that were selected for their ripe appearance from a group of *P. carolinus* collected within a five-day period have shown, when compared in terms of the diameter of their largest eggs, a range from 0.2 mm. to 1.0 mm. This same tendency can be illustrated by the fact that of 70 adult female *P. carolinus* examined July 28, 1944, only 1 had ripe eggs, also of 7 adult female *P. evolans strigatus* measured on that date 2 had ripe eggs.

From the above information it appears that the inshore, shallow-water, summer distribution represents the spawning distribution of these two species. A similar correlation between inshore seasonal abundance and time of spawning of the grey gurnard, *Trigla gurnardus*, of the European coast, has been discussed in papers by Fulton (1899), McIntosh (1900), Meek (1915), and Hertling (1924), but collectively they did not establish an inshore spawning habit, for McIntosh (1900) proved the abundance of spawners offshore (about 25 miles) and in deep water (about 32 fathoms), and Meek (1915) discussed the adult grey gurnards as lingering somewhat offshore and in deeper water for spawning, later joining the immatures in shallow water. As yet there is no evidence to suggest the possibility of such offshore spawning in the two species of *Prionotus* under consideration, whereas ripe specimens are well known in the abundant shallow water populations.

The eggs of *P. carolinus* have been described by Kuntz and Radcliffe (1918) as follows:

> The eggs are spherical in form and 1 to 1.15 mm. in diameter. They are slightly yellowish in color, but highly transparent. The yolk sphere contains a variable number (10 to25) of oil globules of unequal size scattered over the surface. . . . . The egg membrane is thin and horny.

My measurements of ripe eggs agree with these but Breder's unpublished notes, mentioned earlier in this section, give 0.94 to 0.99 mm. as the diameter. Breder gives a somewhat different description saying that the oil globules are "in a somewhat annular band which would, taking the germinal disc as the 'north pole,' describe the 'tropic of capricorn.' The eggs floated with the 'north pole' uppermost, giving the impression that the oil globules were not more buoyant than the surrounding protoplasm."

Kuntz and Radcliffe (1918) describe the development of the *P. carolinus* egg and remark that it is typical of pelagic teleost eggs. Also, that incubation at about 72° F. occupies about 60 hours, the larvae being about 2.8 mm. in total length at hatching (figures of this development are presented on pp. 106–107 of their paper). Eggs observed by Breder hatched in 89 hours at 68° to 70° F.

Except for eggs tentatively identified by Perlmutter (1939) as *P. evolans strigatus*, all descriptions of the eggs of this species that I have found in the literature apparently refer back to the questionably mature ones observed by Breder and described in his unpublished Atlantic City notes. He has informed me through correspondence that the descriptions given by Nichols and Breder (1927) and by Breder (1929) are from this source. In the latter paper the eggs are described as heavy, non-adhesive, transparent and averaging about 1.1 mm. in diameter. The transparency and diameter is supported by my records of the most developed eggs found in ovaries I have examined. The other two characteristics, particularly the demersal character, which is in sharp contrast to the properties of *P. carolinus* eggs, are open to question for these eggs were not successfully fertilized and buoyancy may be too delicately balanced to be determined from unfertilized eggs, even if they were known to be ripe. Doubt on this point was increased in my mind on observing that seemingly ripe but unfertilized *P. carolinus* eggs remained afloat for only a few minutes when placed in sea water; furthermore, such papers as that of Walford (1938) dealing with the delicate balance between the buoyancy of haddock eggs and sea water of varying density impress one with the complexities of this feature of a species' eggs.

Age and Rate of Growth

Prionotus carolinus

The growth rate of *Prionotus carolinus* may first be analyzed on the basis of length-frequency distributions of populations sampled. Figure 1 (see p. 121) based on all fish taken by shrimp trawl in Menemsha Bight, Vineyard Sound, in 1943, lends itself to simple interpretation. It shows a mode at 4 cm. standard length,[6] another at 14 cm., and a third at 23 cm. The fish represented by the mode at 4 cm. were all collected on one trip, that of August 18. They are similar in size to other small *P. carolinus* taken in various habitats on dates immediately following the breeding season. All records of such small specimens are grouped together in the first mode of Figure 3. In addition to the Menemsha Bight fish this mode (Fig. 3) includes those taken with ½-inch (stretched measure) seine along the sandy beaches at Great Harbor, Woods Hole, on August 13 and 25, 1943; also those taken with shrimp trawl in from 2 to 10 fathoms in Buzzards Bay near the Weepecket Islands, August 27, 1943, and in from 2 to 7 fathoms in Vineyard Sound near Waquoit, September 2, 1943. The fish of all these collections are but slightly advanced over the fish 3.0 cm. in total length described by Kuntz and Radcliffe (1918) in concluding their account of the embryology and late larval development of this species; so there is little doubt that fish of this size and, therefore, the first mode of Figure 1, represent the young-of-the-year.

[6] Standard length, used consistently throughout this paper except where otherwise noted, represents the distance from the tip of the snout to the posterior end of the vertebral column. The original measurements were made to the nearest ½ cm. and many were made directly in standard length by feeling the caudal vertebrae through the flesh, a technique checked by occasional dissections. Measurements made in total length, not preferred because of the frequency of damaged caudal fins, were changed to standard length by conversion as follows:

P. carolinus—standard length = 76.5% of total length
P. evolans strigatus—standard length = 78.4% of total length

It follows that the next mode of Figure 1 at about 14 cm., represents the one-year-olds and the third mode represents fish at least two years old.

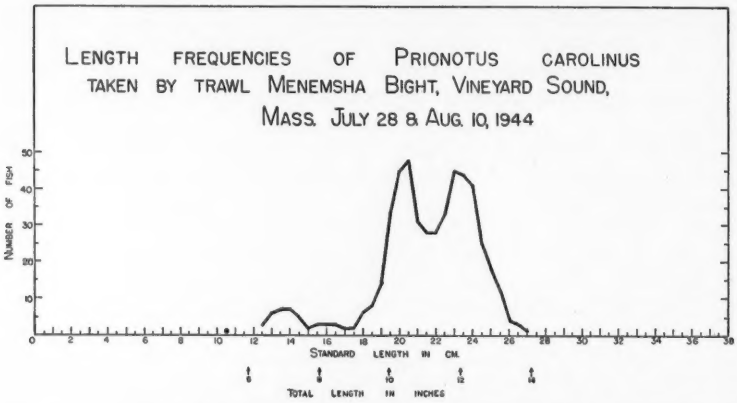

LENGTH FREQUENCIES OF PRIONOTUS CAROLINUS
TAKEN BY TRAWL MENEMSHA BIGHT, VINEYARD SOUND,
MASS. JULY 28 & AUG. 10, 1944
NUMBER OF FISH
STANDARD LENGTH IN CM.
TOTAL LENGTH IN INCHES

Fig. 2. Length–frequency distribution of *Prionotus carolinus* taken by shrimp trawl in less than 12 fathoms in Menemsha Bight, July 28 and August 10, 1944. Data smoothed as in Fig. 1.

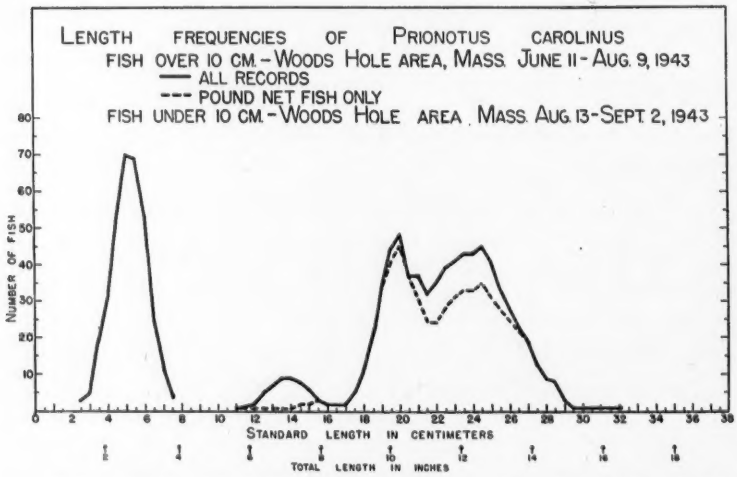

LENGTH FREQUENCIES OF PRIONOTUS CAROLINUS
FISH OVER 10 CM. - WOODS HOLE AREA, MASS. JUNE 11 - AUG. 9, 1943
ALL RECORDS
POUND NET FISH ONLY
FISH UNDER 10 CM. - WOODS HOLE AREA, MASS. AUG. 13 - SEPT. 2, 1943
NUMBER OF FISH
STANDARD LENGTH IN CENTIMETERS
TOTAL LENGTH IN INCHES

Fig. 3. Length–frequency distribution of *Prionotus carolinus* from the Woods Hole, Mass., area in 1943. All specimens over 10 cm. were taken from June 11 through August 9, with pound net catches shown by broken line and pound net plus shrimp trawl catches shown by solid line. The specimens under 10 cm. were taken from August 13 through September 2. Data smoothed as in Fig. 1.

Selectivity of gear is questionable as an explanation for the relatively large numbers in this 23 cm. mode as contrasted with the group at 14 cm. If

there is any selectivity it must involve a tendency for the 14 cm. group to be distributed elsewhere, for this graph shows that the gear is quite capable of catching even the smallest size group. It is more probable that the relatively large size of the broad mode at 23 cm. is due, in part at least, to the summation of several age-groups two years old and above falling close together in the expected plateau phase of their growth curve.

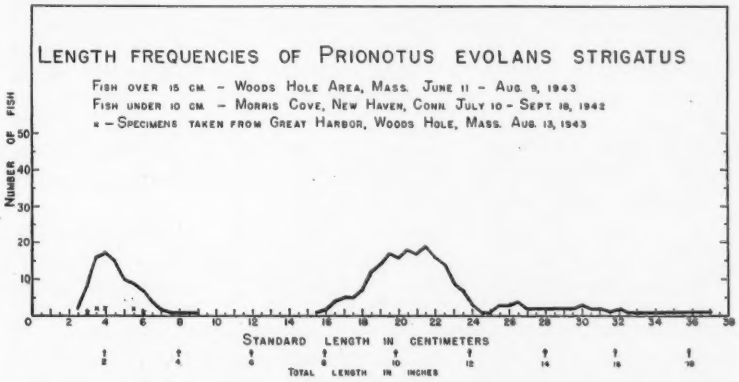

LENGTH FREQUENCIES OF PRIONOTUS EVOLANS STRIGATUS
FISH OVER 15 CM. – WOODS HOLE AREA, MASS. JUNE 11 – AUG. 9, 1943
FISH UNDER 10 CM. – MORRIS COVE, NEW HAVEN, CONN. JULY 10 – SEPT. 18, 1942
x – SPECIMENS TAKEN FROM GREAT HARBOR, WOODS HOLE, MASS. AUG. 13, 1943
NUMBER OF FISH
STANDARD LENGTH IN CENTIMETERS
TOTAL LENGTH IN INCHES

Fig. 4. Length–frequency distribution of *Prionotus evolans strigatus*. Includes specimens recorded from pound nets in the Woods Hole, Mass., area June 11 through August 9, 1943, and those taken by seine from Morris Cove, New Haven, Conn., July 10 through September 18, 1942, the former all being over 15 cm., the latter all being less than 10 cm. Data smoothed as in Fig. 1. Records of the small specimens collected from Great Harbor, Woods Hole, August 13, 1943, are inserted with cross marks.

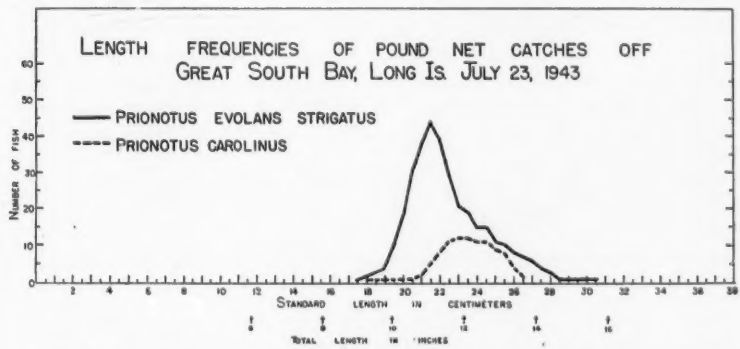

LENGTH FREQUENCIES OF POUND NET CATCHES OFF GREAT SOUTH BAY, LONG IS. JULY 23, 1943
PRIONOTUS EVOLANS STRIGATUS
PRIONOTUS CAROLINUS
NUMBER OF FISH
STANDARD LENGTH IN CENTIMETERS
TOTAL LENGTH IN INCHES

Fig. 5. Length–frequency distribution of *Prionotus carolinus* and *Prionotus evolans strigatus* which were sold on the wholesale market after being caught by pound net off Great South Bay, Long Island, July 23, 1943. Fish too small for marketing have been culled from these lots. Data smoothed as in Fig. 1.

Figure 2 represents shrimp trawl catches made in Menemsha Bight on two trips taken in 1944. No young-of-the-year were taken (the last of these

trips being earlier than the August 18 date on which such specimens were collected in 1943) and few one-year-olds were taken, but, as far as available, the data do agree with those presented in Figure 1.

Figure 3 is a summary of all the *P. carolinus* measured from the Woods Hole region (Buzzards Bay and Vineyard Sound) during a selected 60-day period, June 11 through August 9, 1943, plus fish under 10 cm. standard length taken from August 13 through September 2, none of these having been collected during the earlier period selected for available records of larger specimens. If, in referring to this graph, one considers pound net catches only, there is no evidence of a mode at 14 cm. but this may well be the result of the large mesh of the gear and its questionable effectiveness in capturing smaller specimens. When the shrimp trawl catches are included, however, the mode becomes apparent in spite of the comparatively few trawler-caught fish involved. This graph, therefore, gives further support to the growth rate interpretation given to Figure 1.

In the third major mode of Figures 2 and 3 there is a suggestion of two smaller modes, one at about 20 cm. standard length and the other at about 23½ cm. This might be viewed as evidence of a two-year-old group averaging approximately 20 cm. in length and a group of fish three years and older averaging 23½ cm. Such a concept is not supported by Figure 1 or by the commercial trawl and pound net catches represented by Figures 5, 6, and 7. The numbers of fish in these two minor modes also have a bearing on the interpretation to be made. Figure 2, derived from shrimp trawl records considered comparatively free of selectivity, would contradict the expected tendency for numbers to decrease with age if either of these minor modes, both of which are larger than the 14 cm. mode, were represented as a distinct age-group. The possibility of dominant year-classes might be offered as an explanation of these relatively large numbers except that on such an assumption the large 20 cm. group should have been evident as a large 14 cm. mode (one-year-olds) in the previous year's records as given in Figure 1, possibly even in Figure 3. Also, if each minor mode noted, two in 1943 and two in 1944, were to be interpreted as a distinct year-class, the hypothesis would call for an improbable situation with three successive dominant year-classes.

Additional evidence as to growth rate may be obtained from scale studies. As Walford and Mosher (1943) so aptly state:

> The scales and otoliths of most fishes are characterized by folds or sculpturing in which variations of pattern may be related to age. If they are so related, for a given species, they need not correspond in number with years of life; or, if they do correspond, they may not be recognized, for they may be so obscure as to be counted incorrectly. It is no wonder, then, that scale and otolith reading is a process peculiarly open to subjective influences, and requires, for serious work, a stringent test and proof of validity.

In *P. carolinus* both scales and otoliths were examined. The latter were read in their entirety and along cut surfaces or sections, some of which were polished in an effort to bring out distinctive features; however, the extreme discrepancy in otolith readings from fish of the same length coupled with

the easily observed variability in the type of otolith markings in material from different fish showed that these could not be used.

Early studies on the scales revealed markings so numerous, confused, and indistinct that no progress was made until a series of scales from one-year-old fish (as judged from the above interpretation of length-frequency data) was analyzed for the presence of a distinctive marking that might

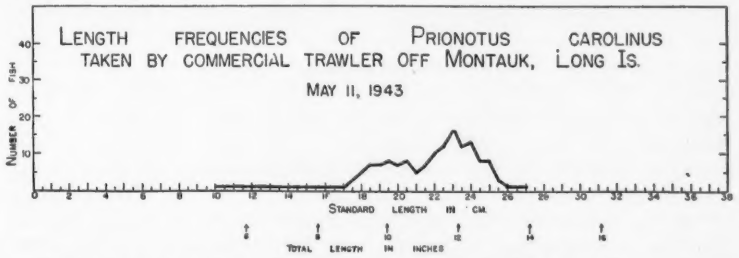

LENGTH FREQUENCIES OF PRIONOTUS CAROLINUS
TAKEN BY COMMERCIAL TRAWLER OFF MONTAUK, LONG IS.
MAY 11, 1943
NUMBER OF FISH
STANDARD LENGTH IN CM.
TOTAL LENGTH IN INCHES

Fig. 6. Length–frequency distribution of *Prionotus carolinus* taken by commercial trawler off Montauk, Long Island, in about 8 fathoms, May 11, 1943. Data smoothed as in Fig. 1.

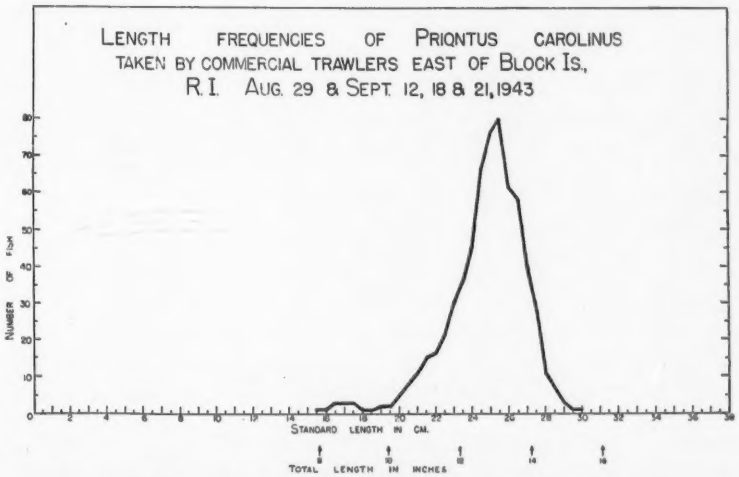

LENGTH FREQUENCIES OF PRIONTUS CAROLINUS
TAKEN BY COMMERCIAL TRAWLERS EAST OF BLOCK IS.,
R.I. AUG. 29 & SEPT. 12, 18 & 21, 1943
NUMBER OF FISH
STANDARD LENGTH IN CM.
TOTAL LENGTH IN INCHES

Fig. 7. Length-frequency distribution of *Prionotus carolinus* taken by commercial trawler east of Block Island, Rhode Island, in about 20 fathoms, August 29 and September 12, 18, and 21, 1943. Data smoothed as in Fig. 1.

consistently appear on them.[7] With this series it was noted that by following the circuli from the focus outward one can detect a band, quite variable in width but usually running completely around that part of the scale in which circuli are present, where the circuli have not been laid down with their usual regularity (see Plate I). Continuing outward the regularity is again noticeable, with circuli often running in a somewhat different direction (not

[7] Glycerin jelly mounts as recommended by Van Oosten (1929) proved useful for this study.

concentric with the inner ones) and often spaced differently than before. One such band was found on almost every scale of this series from one-year-old fish not only when they were read as a group but also when they were mixed with scales of fish of greater length and probably greater age and were read without knowledge of their identity. No band of this type was seen on scales from ten fish of the young-of-the-year length-group whereas an additional band of irregular circuli was usually found on scales from fish of about 20 cm. which, on the basis of length-frequency data, should be at least two years old. Thus this marking meets the specification of an annulus formed sometime before the summer collecting dates involved in this study. In practice it was found that the annulus could be most easily detected along the dorsal and ventral aspects of the scales and that the paths of regularly spaced circuli following the bands of irregularity were a great aid in locating these annual marks. It was also found that, in spite of the distinctiveness of the first annulus, the later markings were increasingly vague so any attempt to read scales that might have more than two annuli is fraught with error, a fact taken into account in the discussion of further scale studies which follows.

TABLE I

SUMMARY OF THE NUMBER OF *Prionotus carolinus* OF STATED LENGTH WITH SCALES READ AS HAVING 0, 1, 2, 3, OR 4 ANNULI

Standard length cm.	Number of annuli 0	I	II	III	IV	% of readings discarded, from the series indicated, because of illegibility and conflicting interpretation
Under 10	10					0%
12½–17½		28	1			6%
19		1				19%
19½		1	2			
20			7			
20½		1	6			
21			6	1		
22			1			30%
23			5	4		
23½				2		
24			1	4		
24½				3		
26			1			33%
27½						
28½					1	

The study of scales was continued by preparing mounts representing fish of various sizes, admittedly emphasizing such critical length-groups as those centering around 14, 20 and 23½ cm. All the scale slides were mixed and were read without reference to the length or even the species (scales from *P. evolans strigatus* were studied at the same time) until an interpretation had been made and recorded. Experience with micro-projectors, scale

reading machines, binocular microscopes and dissecting microscopes showed the dissecting scopes to be most useful because of the field of vision, sharp image and desirable light control; consequently, at least two readings were made of every scale (except the simple ones from fish under 10 cm.) with such apparatus, the last two for each being listed under annuli number in the following table or included among those discarded if they did not concur.

Table I includes the observations already mentioned, to the effect that fish of the second mode, around 14 cm. on the length-frequency graphs, have one annulus. Thus two interdependent types of evidence, length-frequency and scale readings, support the interpretation that these are one-year-old fish. It may be further noted that fish of the third mode at 23 cm. have two annuli or more and thus are considered at least two years old.

The question as to whether there is a distinct 20 cm. group of two-year-olds, mentioned earlier in connection with the minor modes of Figures 2 and 3 may now be reviewed in the light of scale evidence. Of 31 fish 19 through 21 cm. in length, representing the first minor code, 21 showed two annular markings. Thus two annuli are commonly but not consistently found on scales of this group and, with 19 per cent of the scales discarded because of illegibility or conflicting readings, an exacting interpretation of the records would not seem justified. The lack of consistent readings is still greater for the 27 fish 23 through 24½ cm., representing the second minor mode, with only 13 giving the predominant 3 annuli reading and 30 per cent being discarded. This summary, correlated with the above-mentioned difficulty of reading successive annuli, does not support an age analysis based on these minor modes.

Weight records have been taken with length records on 435 *P. carolinus*. The standard deviation from a curve fitted to the arithmetic means of these weights is 1.52 oz.[8] By applying the method of least squares to the logarithms of the original data the following relationship was found:

$$W = .0104\, L^{2.99}$$

with W = weight in oz. and L = standard length in in.

The length-weight relationship derived from this sample is thus shown to be close to a cube relationship and might be handled as such for simplified conversions.

The length-weight records show that the 14 cm. (just over 7 in. total length) or one-year-old fish weigh from 1½ to 2 oz., and by the third summer (two-year-olds), when *P. carolinus* attains a length of 19 cm. or more (about 10 in. total length), the weight is over 4 oz. The heaviest fish recorded weighed 1 lb. 11½ oz. and was 14½ in. in total length.

Prionotus evolans strigatus

In considering the age and rate of growth of *Prionotus evolans strigatus* it is immediately recognized that the available length-frequency data are very limited. Catches made with the shrimp trawl, of marked value in the age study of *P. carolinus*, yielded so few specimens of this species (see sec-

[8] The standard deviation from the formula which follows would be no greater than and in all probability less than this.

tion on relative abundance) that true length-frequency curves could not conceivably be drawn from the records. This limits the study to length-frequencies derived from pound net catches which, as explained above, are selective for fish of the larger sizes.

In Figure 4 the *P. evolans strigatus* over 10 cm. are all those taken by pound net in the Woods Hole area during a sixty-day period, June 11 through August 9, in other words the same period used in preparing the length-frequency curve of pound net catches of *P. carolinus* as presented by dotted line in Figure 3. In analyzing the latter figure it was noted that fish under 17 cm. were not taken by the pound net gear except in disproportionately small numbers, this being true to the extent that a smaller age-group was missed altogether. This raises the question whether there is a length-group between the smaller fish taken, by minnow seine and represented by the mode centered at about 4 cm. in Figure 4, and the larger fish whose mode is centered at about 21 cm. There is little doubt but that the smaller fish, which were collected in shallow waters along the beaches soon after the spawning season and which have immature characteristics much like those of the small *P. carolinus* previously described, are young-of-the-year as proposed by Warfel and Merriman (1944). Whether *P. evolans strigatus* about 18 or 20 cm. in length, as shown in Figure 4, are one-year-olds demands careful consideration.

The answer to this question was derived from the study of the scales which had markings (see Plate I) very much like the annuli of *P. carolinus*, except that the distinctiveness noted in the first and sometimes the second annual rings of the latter was lacking from these *P. evolans strigatus* scales. With the exception of the simple scales of fish under 10 cm., at least two binocular microscope readings were made, the last two for each scale being listed in the following table by annuli number or included among those discarded if the readings did not concur. By studying these concurrently with scales of *P. carolinus* it was possible to make these readings without advance knowledge of either the species or the length.

From Table II it is noted that the large majority of smaller fish in the 21 cm. mode have only one annulus. Thus it appears that there is no length group of smaller fish and that this species attains a length of 17 cm. and more by the second summer. With little doubt the 21 cm. mode also includes fish more than one year old but the annuli are too obscure and other readings are too inconsistent to enable a breakdown into age groups.

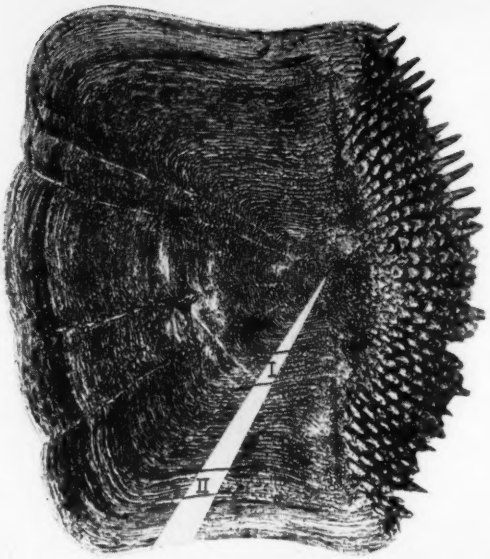
Weight records have been taken with length records on 218 *P. evolans strigatus*. The standard deviation from a curve fitted to the arithmetic means of these weights is 1.81 oz.[9] By applying the method of least squares to the logarithms of the original data the following relationship was found:

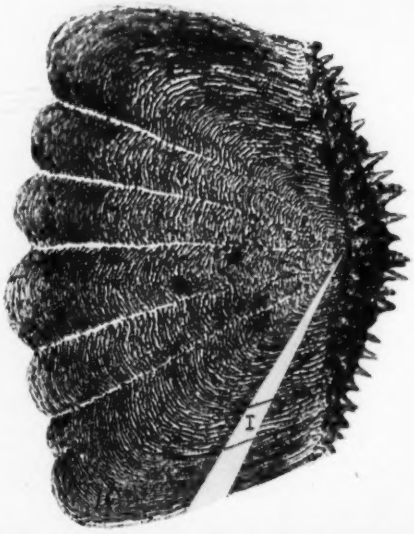
$$W = .00880\ L^{3.12}$$

with W = weight in oz. and L = total length in in.

The length-weight relationship derived from this sampling is thus shown to be slightly greater than a cube relationship, a feature common in other fish analyzed for this according to Hart (1932) and Hile (1936).

[9] The standard deviation from the formula which follows would be no greater than and in all probability less than this.





Upper. Scale from *Prionotus carolinus*, standard length 23 cm., collected August 18, 1943. First and second annuli are indicated by zones labeled "I" and "II" respectively. Actual dorso-ventral measurement of scale = 2.9 mm.

Lower. Scale from *Prionotus evolans strigatus*, standard length 20 cm., collected September 6, 1943. The one annulus present is indicated by zone labeled "I." Actual dorso-ventral measurement of scale = 3.0 mm.

The length-weight records show that by the second summer when the fish are 17 cm. or more (about 9 in. total length) this species has attained a weight of 4 oz. or more, comparing closely with the weight attained by *P. carolinus* in its third summer. This comparison and a comparison of the weight-length formulae show that, with the exception of the small young-of-the-year, *P. evolans strigatus* is decidedly the heavier of the two species at any given length. The implications of these comparisons in commercial practice are brought out in Figure 5 which shows, using the age-length relationships advanced in this paper, that one-year-old *P. evolans strigatus* were commonly saved as being sufficiently heavy for sale whereas the *P. carolinus* saved were at least two-year-olds, the majority probably older.

TABLE II

SUMMARY OF THE NUMBER OF *Prionotus evolans strigatus* OF STATED LENGTH WITH SCALES READ AS HAVING 0, 1, 2 OR 3 ANNULI

Standard length cm.	Number of annuli 0	I	II	III	% of readings discarded, from the series indicated, because of illegibility and conflicting interpretation
Under 10	10				0%
12½		1			
16					22%
16½		2			
17		3	1		
17½		3			
18		2			
18½		1			
19		5	1		
19½		1			27%
20		5			
20½		3	1		
21		4	2		
21½		1	3		
22		6	2	1	
22½		2	3		
23		2			
23½				1	
24			1		
25					44%
25½			2		
26			2	1	
26½			3		
27				1	
27½					
28				1	

The largest *P. evolans strigatus* recorded in this study had a total length of 18½ in. and a weight of 2 lbs. 9½ oz.

FOOD HABITS

The food habits of these two species were studied by analyzing the stomach contents of 216 *Prionotus carolinus* and of 62 *P. evolans strigatus*.

TABLE III

Stomach content analysis of 80 *P. carolinus* taken by trawl in the Woods Hole, Mass., area in 1943 comparing young-of-the-year (under 10 cm. standard length) with older fish

	42 fish (standard length 2.0—6.9 cm.)					38 fish (standard length 13—26 cm.)				
	No. eaten	% of total	No. of stomachs where found	Av. no. per stomach where found	Largest no. in one stomach	No. eaten	% of total	No. of stomachs where found	Av. no. per stomach where found	Largest no. in one stomach
Annelida, undetermined	4	<1%	2	2	2	18	1%	9	2	5
Copepoda, undetermined	549	55%	9	61	320					
Mysidacea	185	19%				2212	64%			
Mysis americana			8	23	40			14	158	1100
Michtheimysis stenolepis			1	1	1					
Cumacea	20	2%				1	<1%			
Diastylis sp.			4	2	2			1	1	1
Undetermined			6	2	3					
Amphipoda	156	16%				578	17%			
Tmetonyx sp.			1	6	6			1	3	3
Ampelisca sp.			4	2	4			9	8	50
Haustorius arenarius								1	1	1
Phoxocephalus holbölli								1	2	2
Gammarus locusta			2	1	1			20	24	124
Unciola irrorata			4	2	3			2	1	1
Gammaridea, undetermined			22	6	12			6	3	13

TABLE III (continued)

Isopoda, undetermined						1	<1%	1	1	1
Decapoda	67	7%				558	16%			
Crago septemspinosus			19	3	8			28	19	80
Natantia, undetermined			2	1	1			1	1	1
Upogebia affinis								1	2	2
Xanthidae, undetermined			3	1	2			3	6	15
Brachygnatha, undetermined			1	1	1			2	2	3
Megalops larva			4	1	2			1	1	1
Collembola, undetermined	1	<1%	1	1	1	1	<1%	1	1	1
Gastropoda	3	<1%				3	<1%			
Odostomia sp.			2	1	1					
Undetermined			1	1	1			3	1	2
Pelecypoda	1	<1%				54	2%			
Solemya velum								1	2	2
Tellina sp.								6	9	50
Undetermined			1	1	1					
Teleostomi	6	1%				4	<1%			
Prionotus carolinus								1	1	1
Heterosomata, undetermined			1	2	2					
Undetermined			4	1	2			3	1	1
Miscellaneous unidentified eggs			2	undetermined	undetermined					

Stomachs studied at first included 18 *P. carolinus* and 22 *P. evolans strigatus* captured in pound nets. The contents of these included many small crustacea plus a wide variety of fishes, including for example herring, *Clupea harengus*, whiting, *Merluccius bilinearis*, mackerel, *Scomber scombrus*, and cunner, *Tautogolabrus adspersus*. The size of the fish eaten was impressive, the outstanding example being the *P. evolans strigatus* 30½ cm. in standard length with a stomach containing four herring, each of which was about 15 cm. in total length. The condition of many of the fish eaten made it seem possible that they had been taken alive but, in view of the fact that these analyses were of *Prionotus* that had been confined in pound nets with other fishes, it seemed questionable that such piscivorous habits were natural. To answer this question and to get more accurate information on food habits, further study was limited to sea robins taken either by trawl or by seine, even though very few *P. evolans strigatus* could be obtained in this way. A quick glance at the various tables and other records of *Prionotus* stomach contents given below shows that these species are not piscivorous; moreover, it should be remarked that the few fish found in the stomachs were all of small size, probably young-of-the-year, and that full stomachs contained a total food volume far below that typically found in the fish-eating pound net specimens.

Tables III through VI present data from many of the stomachs analyzed arranged in groups to show comparisons.[10] Tables III and IV permit a comparison of *P. carolinus* taken from different coastal areas and during somewhat different seasons. They demonstrate that this species consistently feeds chiefly on a variety of small crustaceans such as can be found within a foot or so of the bottom.

Table III compares the food of *P. carolinus* hatched during the summer with that of the older fish and more records on the stomach contents of young-of-the-year of this species are included in Table V. The diets of these contrasting size groups are essentially the same except that the larger fish tend to consume the various food species in larger numbers. An impressive illustration from Table III shows that the young fish that ate *Mysis americana* had an average of 23 in their stomachs whereas the older, larger fish averaged 158. An outstanding exception is seen with respect to copepods,[11] which are eaten in large numbers by the young-of-the-year but are smaller than anything consumed by the older fish.

Available records are not sufficient for a similar tabulation of *P. evolans strigatus* stomach contents. Table VI lists stomach analyses of this species taken from Menemsha Bight in 1944 (none of this species was taken there in 1943) and compares them with analyses of *P. carolinus* of the same size and from the same area; i.e., taken with the same short haul of the shrimp trawl. Table V compares the young-of-the-year of both species as taken

10 A valuable service in the identification of certain puzzling amphipods was rendered by Clarence R. Shoemaker of the U.S. National Museum. Professor George L. Clarke, Mr. George M. Gray, Dr. Richard E. Lee, Professor J. S. Rankin, and many other Woods Hole investigators gave assistance in striving for accurate identification of stomach contents. Outstanding references used for this study included "Amphipoda of Southern New England" by Holmes (1905), "The Arthrostraca of Connecticut" by Kunkel (1918), and Verill and Smith's (1874) report on the invertebrates of Vineyard Sound.

11 Professor George L. Clarke has identified some of these copepods for me and has determined the presence of several common species that frequent the shallow waters close to shore, including *Centropages hamatus* and *Pseudocalanus minutus*.

TABLE IV

	Stomach contents of 12 *P. carolinus* (standard length 18–24½ cm.) collected by trawl off Montauk, Long Island, May 11, 1943					Stomach contents of 13 *P. carolinus* (standard length 17–27½ cm.) collected by trawl east of Block Island, Rhode Island, September 18, 1943*				
	No. eaten	% of total	No. of stomachs where found	Av. no. per stomach where found	Largest no. in one stomach	No. eaten	% of total	No. of stomachs where found	Av. no. per stomach where found	Largest no. in one stomach
Annelida, undetermined						8	<1%	8	1	3
Mysidacea	20	16%				52	2%			
Mysis americana			5	4	10			4	13	28
Cumacea	22	17%				26	1%			
Diastylis sp.			2	1	1			5	4	7
Undetermined			4	5	11			3	2	4
Amphipoda	74	58%				2138	96%			
Archomenella pinguis								2	1	1
Ampelisca sp.								13	3	10
Phoxocephalus holbölli								3	1	1
Paraphoxus spinosus			1	1	1					
Monoculodes edwardsii			6	9	30					
Gammarus locusta								13	153	564
Cerapus tabularis								10	3	10
Unciola irrorata			1	1	1			11	4	15
Aeginella longicornis								6	5	8
Gammaridea, undetermined			3	6	30			1	1	1
Isopoda	3	2%								
Chiridotea caeca			3	1	1					
Decapoda	8	6%				2	<1%			
Crago septemspinosus			4	2	3			2	1	1
Pelecypoda						2	<1%			
Nucula sp.								1	1	1
Cardium pinnulatum								1	1	1
Teleostomi	1	1%								
Anguilla rostrata			1	1	1					
Miscellaneous unidentified eggs			3	undetermined	undetermined			4	undetermined	undetermined

* The stomach of one of these 13 fish was empty.

63 additional *P. carolinus* stomachs from fish collected off Block Island, September, 1943, were analyzed in the aggregate (without records for each individual) and were found to substantiate the above data.

TABLE V

Comparison of the stomach contents of young-of-the-year of *P. carolinus* and *P. evolans strigatus* taken by seine in Great Harbor 8/13/43

	P. evolans strigatus 10 fish (standard length 3.3—6.0 cm.)					*P. carolinus* 7 fish (standard length 4.1—5.6 cm.)				
	No. eaten	% of total	No. of stomachs where found	Av. no. per stomach where found	Largest no. in one stomach	No. eaten	% of total	No. of stomachs where found	Av. no. per stomach where found	Largest no. in one stomach
Annelida, undetermined						1	<1%	1	1	1
Copepoda, undetermined	912	98%	4	228	320	200	89%	2	100	160
Cumacea *Diastylis* sp.	1	<1%	1	1	1					
Amphipoda *Cerapus tabularis*						3	1%	1	3	3
Decapoda *Crago septemspinosus* Megalops larva	18	2%	9	2	4	19	8%	6 1	3 1	8 1
Teleostomi, undetermined						1	<1%	1	1	1
Miscellaneous unidentified eggs			4	undetermined	undetermined			3	undetermined	undetermined

TABLE VI

Stomach contents of 11 *P. evolans strigatus* taken from Menemsha Bight July 28 and August 10, 1944. From each haul in which this species was taken a corresponding number and similar size group of *P. carolinus* was analyzed for the comparison included in this table.

	Mysis americana			*Ampelisca* sp.			*Gammarus locusta*			*Crago septemspinosus*			*Tellina tenera*			*Prionotus carolinus*			Pleuronectidae, undetermined			Teleostomi, undetermined		
	No.	Av.	Max.	No.	Av.	Max.	No.	Av.	Max.	No.	Av.	Max.	No.	Av.	Max.	No.	Av.	Max.	No.	Av.	Max.	No.	Av.	Max.
Haul #1 July 28, 1941																								
4**P.e. strigatus* SL 21½–22½ cm.	2	69	112							4	5	10				1	1	1	2	4	4			
4 *P. carolinus* SL 20½–24 cm.	3	53	140	1	2	2	3	11	20	4	11	24	1	11	11							1	1	1
Haul #3 July 28,1944																								
2 *P.e. strigatus* SL 18½ & 22 cm.	1	1	1	1	3	3	1	128	128	1	8	8				1	5	5	1	1	1	2	1	1
2 *P. carolinus* SL 19 & 22 cm.	1	75	75				1	80	80	1	7	7	1	2	2							1	4	4
Haul #4 July 28, 1944																								
3 *P.e. strigatus* SL 21½–30 cm.	2	60	112	1	6	6	1	1	1	2	64	70				2	4	4				3	1	1
3**P. carolinus* SL 24½–26½ cm.	1	1	1	2	5	7	2	80	108				2	1	1									
Haul #1 August 10, 1944																								
1 *P.e. strigatus* SL 23 cm.	1	92	92							1	10	10										1	1	1
1 *P. carolinus* SL 23½ cm.	1	364	364	1	1	1				1	18	18												
Haul #2 August 10,1944																								
1 *P.e. strigatus* SL 20½ cm.										1	7	7				1	2	2				1	7	7
1 *P. carolinus* SL 18½ cm.				1	4	4	1	66	66	1	23	23	1	2	2									

* 1 of these fish had an empty stomach.

Key to columns: No. = no. of stomachs where found. Av. = average no. per stomach where found. Max. = largest no. in one stomach.

Other forms eaten in small numbers and mentioned here for completeness are:

for *P. carolinus*: Annelida, undetermined; *Michtheimysis stenolepis; Unicola irrorata;* Isopoda, undetermined; Natantia, undetermined; *Turbonilla elegans*

for *P. evolans strigatus*: Annelida, undetermined; *Michtheimysis stenolepis; Diastylis bispinosus; Unciola irrorata; Pagurus longicarpus; Cancer borealis;* Brachygnatha, undetermined; Megalops larva; *Ensis directus;* unidentified eggs.

together in Great Harbor, Woods Hole, August 13, 1943. The tables indicate a general similarity in the feeding habits of these two species, also demonstrated by the *P. evolans strigatus* caught in pound nets which contained, besides the fish mentioned earlier, a variety of small crustacea, etc., very similar to the variety found in *P. carolinus* stomachs and undoubtedly consumed before the fish entered the pound.

Twenty-eight young-of-the-year *P. evolans strigatus* collected in Morris Cove, New Haven, Connecticut, on August 7 and 21 and September 4, 1942, had eaten only *Crago septemspinosus* (except for one fish that had also consumed three undetermined teleosts). The latter feeding is far more uniform than observed elsewhere in my analyses for either species. It would seem to indicate a high availability of the *Crago* eaten and the probability is that, under similar conditions, *P. carolinus* would have eaten the same.

From Table VI it may be noted that, though fish remained a very minor article of the diet, the *P. evolans strigatus* analyzed had eaten more of them than had *P. carolinus*. Data on this possible difference is meagre but this table points to what may be a definite tendency. In the collections made from Vineyard Sound, near Waquoit, September 2, 1943, of four *P. carolinus* analyzed (about 17 cm. standard length) one had a young *P. carolinus* in its stomach and all had eaten the typical assortment of small crustacea; whereas, of the two *P. evolans strigatus* taken, one (23½ cm. standard length) had eaten a small flying squirrel, *Cephalacanthus volitans*, the other (12½ cm. standard length) had eaten an unidentified teleost and neither fish showed any other food of consequence in its stomach. And from the "Hell Hole" northeast of Block Island, Rhode Island, fifty-two large *P. carolinus* had fed largely on a variety of small crustacea, whereas the one large *P. evolans strigatus* taken on the same date had eaten forty-five of the small shrimp, *Palaemonetes vulgaris* and one skate, *Raja erinacea*. Certainly its larger mouth and its rapid rate of growth would correlate with the interpretation that *P. evolans strigatus* is the more piscivorous of these two species.

There are certain factors not evident from tabular form that should be mentioned. The annelida found were in distorted form, not lending themselves to identification. Perhaps mechanical and digestive effects account for the poor condition of these soft-bodied forms as contrasted with the more typical food organisms having resistant exoskeletons, etc. Not indicated in the tables is the fact that a large majority of the stomachs examined contained a few sand grains and hard inorganic particles of sand grain dimensions. A few stomachs contained small scraps of plant tissues ranging from fragments of larger plant detritus to bits of the smaller filamentous algae.

The data given are in general agreement with scattered published reports (often in the form of brief comments on a few fish examined) on the food habits of these species, such notes being found for example in Sumner, Cole and Osburn (1913), Bigelow and Welsh (1925), and Hildebrand and Schroeder (1938). Summarizing the present, more complete study, it can be said that small crustacea were eaten by *P. carolinus* and *P. evolans strigatus* in far greater numbers and in greater amounts by volume and weight than were the members of any other class or phylum. Narrowing comparisons to orders it is evident that the Amphipoda were represented in greatest variety,

weight and volume. The amphipod, *Gammarus locusta,* and the mysid, *Mysis americana,* were the two most abundant species in the stomachs analyzed, the former being decidedly the more important in terms of weight. The smallest forms eaten were the copepods which, as mentioned above, were frequently found in large numbers in the stomachs of the young-of-the-year. *Crago septemspinosus* represents the maximum size of the food species commonly found and, while its numbers were seldom great, the comparatively large volume of individual specimens ranks it as an outstanding item.

Though they have diverse habits (some are burrowers and some are commonly found at mid-depths as plankton), practically all these food species frequent the zone on and within a foot or two above the bottom deposits. The use of this zone on and over the bottom is emphasized by a comparison of the stomach contents of *Prionotus* taken in Menemsha Bight and the relative abundance of bottom invertebrates in the Bight as reported by Lee (1944) from a quantitative study of bottom samples. *Mysis americana, Gammarus locusta,* and *Crago septemspinosus* were the most numerous forms in the *Prionotus* stomachs but none of these are in the list of the eight most common organisms taken in Lee's samples. In fact *Mysis americana* is not mentioned in the published record of these samples and, like several other forms in the *Prionotus* diet, was probably taken in very small numbers if at all, for his bottom sampler would bring up a given portion of sand and mud useful for a quantitative measure of organisms burrowing therein but not suitable for observations on the fauna immediately over the bottom. Some correlation might be expected between the abundance of organisms in such bottom samples and the stomach contents of species eating from the actual bottom deposits. On the other hand, should the fish involved eat predominantly from the fauna just above, or on but not burrowed in the bottom materials, such a correlation would be lacking as in *P. carolinus* and *P. evolans strigatus.*

A bottom of fine sand was found by Lee (1944) to have the richest fauna of the five distinct bottom types he recognized in Menemsha Bight. The fact that the *Prionotus* were taken in greatest numbers over this type bottom may well indicate that this high productivity in the bottom sediments is matched by a comparable abundance of animals directly over them.

Summary

The life histories of the common sea robin, *Prionotus carolinus,* and the northern striped sea robin, *P. evolans strigatus,* were investigated simultaneously and thus on a comparative basis. In the southern New England coastal waters, where this study was undertaken, both species are abundant from late April, when the inshore temperature is just above 40° F., till late in October, when the temperature has dropped slightly below 60° F. Their presence inshore overlaps their respective spawning seasons, which extend from mid-June through early August for *P. carolinus* and for about the same period, possibly somewhat shorter, for *P. evolans strigatus.*

Records from commercial fish trawlers and shrimp trawls used for research are discussed as valid indicators of relative abundance of these two common species. Such data indicate a ratio of about 50 *P. carolinus* to 1

P. evolans strigatus in the region studied. Disproportionately high pound net catches of *P. evolans strigatus* are interpreted as resulting from a greater tendency for this species to inhabit or to move about in waters within a couple of hundred yards of the shore; perhaps both factors are involved.

Length-group and scale studies indicate that *P. carolinus* attains a standard length of about 14 cm. (just over 7 in. total length) and a weight of 1½ to 2 oz. during the second summer (as one-year-olds) and a length of 19 cm. or more (about 10 in. total length) with a weight of over 4 oz. during its third summer. Similar studies show that *P. evolans strigatus* attains a standard length of 17 cm. or more (about 9 in. total length) with a weight of 4 oz. or more in its second summer, being almost as large as specimens of *P. carolinus* a year older. In both species one-year-olds were found with eggs of mature size though the ovaries and egg numbers were small.

Detailed analyses of 278 stomachs of *P. carolinus* and *P. evolans strigatus* were made. The records show that both fish feed chiefly on small crustacea that occur on or within a few inches of the bottom in the sand and mud areas where these fish are found. In number of species, number of individuals and volume, the Amphipoda exceeded all other orders in the stomach contents. *Gammarus locusta, Mysis americana* and *Crago septemspinosus* were the outstanding species found in the fish examined. Very few fish were found in the stomachs studied. The only marked difference between the food habits of larger and smaller fish was a rough correlation between size of the fish and volume of its stomach contents, the larger fish having taken food species in roughly the same proportions but in greater numbers.

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On the Zoogeography of the Holarctic Region[1]

By KARL PATTERSON SCHMIDT

ONE of the most paradoxical of zoogeographic relations lies in the fact that the faunas of western Europe and western North America have a considerable number of forms in common and confined to these two areas, or are otherwise faunally comparable, while eastern Asia and eastern North America are similarly and even more strikingly allied. This faunal correspondence, and the parallel floral relations, complicated as they are by the varied elements in each of the four areas concerned, is at least sufficiently distinct to have excited the interest of many students of systematic botany and zoology. The relation between the flora of eastern North America and that of eastern Asia was pointed out by Asa Gray as early as 1846, and it is said that Chinese students in universities in the eastern United States have been made homesick by the sight of the familiar sassafras.

The bridge-building school of zoogeographers has found these relations

1 At the instance of my colleague in zoogeographic interests, Mr. M. Graham Netting, I have slightly modified, corrected, and amplified the essay of the same title written in 1928 and published in the Lingnan Science Journal, Vol. 10, in 1931. The essay had been prepared for the 1928 Science Conference at Lingnan University but was mislaid at Lingnan after being somewhat delayed in transmission, and there was no opportunity to correct MS. or proof, even after the four-year lapse between preparation and publication. It is felt that the interpretation of post-glacial faunal resurgence, in the light of the eccentricity of the world glaciation, justifies the emphasis of republication.—K.P.S.

puzzling, for it is certainly difficult to account for them by supposing a former connection of Europe and California (for example) by a trans-oceanic land-bridge that leaves out eastern North America. This very hypothesis, however, has been proposed by Scharff (1912), who extends the land connection from the Mediterranean region to Central America and Mexico (and so to western North America) via the West Indies. He is not very clear about the connection with Asia, which is to explain the fauna of the southeastern United States, but follows Ortmann in allowing for a broad connection at Bering Strait in the Cretaceous.

A certain amount of new and interesting data has become available for the study of these problems, even from the purely faunistic viewpoint. The vital blow dealt to the bridge-building school by Matthew's masterly résumé of the paleontological evidence (1915) will not be touched upon here, except insofar as I shall try to bring a little of the evidence from the existing fauna into line with Matthew's general hypothesis of dispersal.

Turning first to the faunal relations between western North America and Europe, especially western Europe, I may summarize briefly the principal groups of animals concerned, drawing heavily for this purpose from Scharff, whose diligent assembling of evidence redeems for me an otherwise futile work. In spite of divergence of opinion as to their classification, a number of snails and slugs seem to exemplify this relationship, and the family of slugs Arionidae is plainly confined to the western coast of the United States and nearly confined to western Europe, ranging, however, sparingly into Siberia and China. Among insects, the general aspect of the Californian butterfly fauna is strikingly European and strikingly unlike that of southeastern North America, and in this group nine species are considered identical in the two areas. The Eleodinae, a subfamily of the tenebrionid beetles, is characteristic of California and the Mediterranean region. Certain genera of dung-beetles have a similar distribution. The remarkable honey-ants are confined to southwestern North America, the Mediterranean region, and Central Asia. Other ants have a similar distribution, and the common *Formica cinerea* and *F. rufibarbis* are considered to be identical in the two areas in question. A species of centipede, *Theotops erythrocephalus,* is found in California and Oregon and in southwest and central Europe. The common European crayfish (*Potamobius*) is represented by species of the genus in western North America, while eastern North America and eastern Asia are inhabited by other genera (*Cambarus* and *Cambaroides*).

Among vertebrates, by far the most striking case is that of the plethodont salamanders of the genus *Hydromantes,* with a species in the high Sierras of California and two species in Europe, confined to Sardinia and to northern Italy and France. The poverty of the fresh-water turtle fauna in the two areas is surprising, and each has only a single *Hyla.*

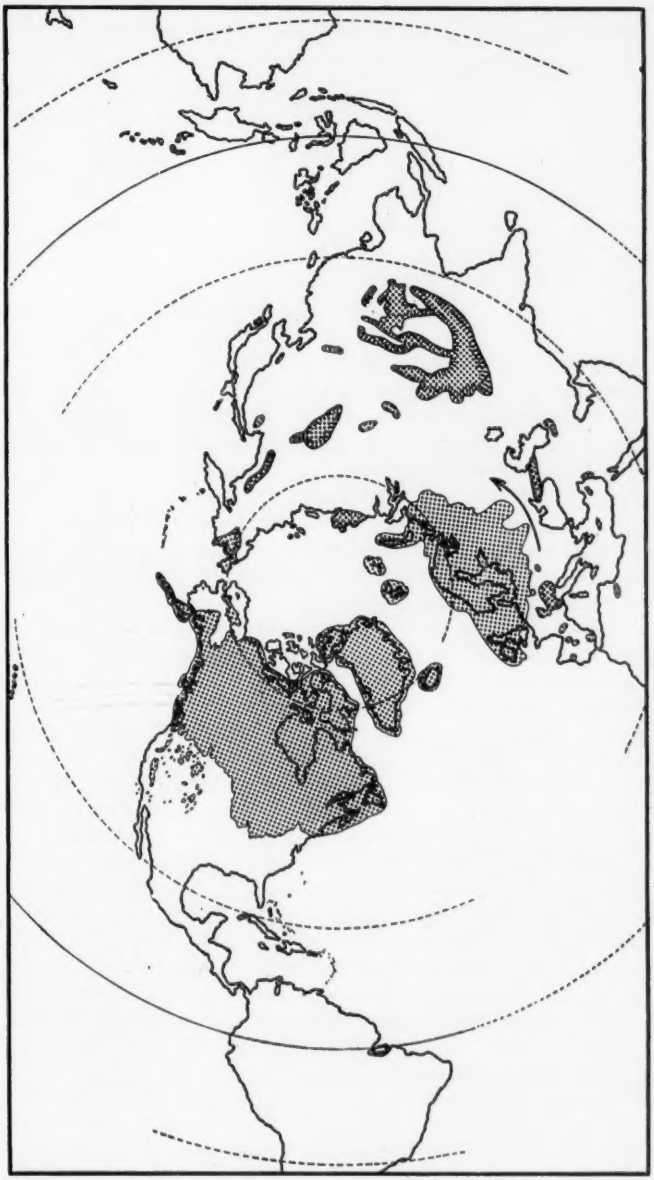
I have long been of the opinion that zoogeographic hypotheses should be based upon geological facts, and not geological hypotheses upon zoogeographic facts. In this respect, I feel bound to reject the 'land-bridge' speculations, which have had a considerable vogue among students of animal distribution, and to range myself with Wallace and Matthew in regarding the per-

manence of the continents (in their larger outlines) as the only scientific basis for zoogeographic speculation. In casting about for geological factors to explain the faunal relations above outlined, I examined the maps of the Pleistocene glaciation in the current geological manuals (see especially Chamberlain and Salisbury, 1907, 3: 423, fig. 529). The distribution of continental glaciers is represented as highly eccentric. North America and Europe are shown to have been heavily glaciated, while northern Asia was almost entirely free from ice. A variety of explanations suggest themselves for this surprising fact, of which the simplest would be to ascribe the want of indicated glaciation to insufficient knowledge. The Russian geologists, however, must have an intimate acquaintance with glacial phenomena at home, and could scarcely have overlooked them in Siberia. Dr. Frederick K. Morris of the geological staff of the American Museum of Natural History's "Third Asiatic Expedition" assures me, in conversation, that there is no evidence of glaciation in Mongolia, which lies between latitudes 42° and 54° N., while the southern limit of the continental glacier in North America was at about 38° and in Europe 50°.

Leaving the explanation of this world pattern of glaciation to the geologists, the facts clearly have an important bearing on certain problems of historical zoogeography. Its importance does not seem to have been realized in current discussions of animal distribution. I venture to suggest that the freedom from ice of northeastern Asia may afford a direct explanation of the faunal relations between Europe and western North America.

During the advance of the continental glaciers in Europe, the animal population retreated to the south, and the glacial relict fauna of the Alps clearly illustrates this southward advance of the northern fauna. A second and perhaps even more important refuge for the preglacial European animals was available in unglaciated northern and central Asia, and the eastward flow of the refugees must have been accentuated by the east-west trends of the Eurasian mountain systems. On the other hemisphere, the North American fauna, as far west as the Rocky Mountains, must have retreated rather completely to the southern half of the continent. The detailed evidence that retreat and advance of the fauna accompanied advance and retreat of the ice is presented by Chamberlain and Salisbury.

The final retreat of the glaciers opened up vast territories on both continents for repopulation by more southern forms of animals and plants. The fossils from interglacial periods exhibit the extent of the earlier northward migrations, and during a part of the Pleistocene, Bering Strait is known to have been closed, and an Asiatic-North American connection was thus available for that part of the fauna which could exist under the Alaskan climatic conditions. The expansion of a part of the previously crowded Siberian fauna into Alaska and thence into western North America, with a contemporaneous and more complete westward migration into Europe, affords an extremely satisfactory explanation of the remarkable similarities between the west American and European faunae. Scharff has adequately emphasized the westward migration of the Siberian element in the European fauna, but has not recognized the similar element in western North America as a correlative and



World pattern of glaciation in the northern hemisphere northern and central Asia being without a continental glacier. After Chamberlain and Salisbury.

probably contemporary migration from the same center, a part of the general postglacial expansion of the Siberian fauna. It is not impossible that the "Völkerwanderungen" represent a late phase of this phenomenon, and in historic times the spread of the black rat and the brown rat suggest that it still continues. The resurge northward of the semi-tropical Chinese fauna with modification of the postglacial climate would add to the "faunal pressure" in eastern Asia. The Rocky Mountains, presenting a highway for the southward migration of northern forms, offer an effective barrier to the westward spread of the preglacial fauna of the southeastern United States. A further avenue of southward dispersal may have been a hypothetical corridor between the mountain glaciers of the Rockies and the western border of the great northeastern continental glacier.

The circumpolar distribution of the more boreal forms is an allied phenomenon, but it seems likely that it depends on a number of other factors, and that ice floes may have played a part in the dispersal of life in this region. The circumpolar species of fresh water fishes (*Esox lucius,* the northern pike, *Coregonus,* the whitefish, *Perca* sp., the yellow perch, and the ling, *Lota*) contribute an item of evidence on the relatively recent existence of a closure of Bering Strait. The individuals of these forms in Europe, Siberia, and North America are either conspecific or so closely allied as to be scarcely distinguishable. They may have spread through coastwise marshes, or their dispersal may have been furthered by a freshening of the surface waters of the Arctic Ocean with the melting ice in spring, since fresh water tends to float on the oceanic salt water.

In addition to the fairly clear cut evidence of an alliance between the west European and west American faunae, there are a large number of related forms that fall in line with the general argument, but appear to represent earlier phases of this wave of dispersal and, in some cases, perhaps, a parallel wave of much earlier date. The present distribution of the bisons may be instanced. The two living species are confined to western North America and Europe (the Carpathians and Caucasus), but there was a Pleistocene development in North America of rather numerous species, suggesting the expansion of a group in a newly occupied territory. The Rocky Mountain goat is perhaps related to the chamois, but the amount of difference between them is too great for any evidence of recent migration. The wild sheep of the Rockies and of the mountains of Asia do appear to be a part of a Pleistocene and recent dispersal. The Pacific Coast skink of western North America (*Eumeces skiltonianus*) agrees well enough with the hypothesis of a northern Asiatic origin, but its closest relatives are in southern China instead of in Europe. *Emys,* with a species in Central Europe and one in the mid-western United States presents a curious parallel with the bisons.

The resemblance between the west European and west North American faunae thus seems to be essentially a relation based on a late Tertiary, Pleistocene, and Recent dispersal. I wish to discuss the second relation, between the animals of eastern North America and eastern Asia, in this connection because it presents a strong contrast with the first, as a much earlier series of migrations, probably in late Mesozoic and early Tertiary times, interchanging

via the same Bering Strait bridge. For the consideration of this second problem the herpetological evidence is especially instructive.

The faunae of eastern Asia and eastern North America present certain general resemblances in their composition. Both are rich in salamanders and in freshwater turtles of the family Emydidae. The still more aquatic soft-shelled turtles of the genus *Trionyx* are well represented. Of the groups of amphibians and reptiles now confined to these two regions (and found in both) the most important are the cryptobranchid salamanders, the crocodilian genus *Alligator,* and the spoon-billed sturgeons, *Psephurus* in China and *Polyodon* in the Mississippi. The two areas do not have any species of amphibians or reptiles in common, though it was long a commonplace of zoogeographic compilations to state that the common ground skink of the southeastern United States (*Leiolopisma laterale*) is indistinguishable from a similar form in China. Re-examination of this question with the ample material collected by Mr. Clifford H. Pope, of the Third Asiatic Expedition of the American Museum of Natural History, shows that the Chinese skinks that have been referred to *Leiolopisma laterale* fall into four or five distinct forms, and all of them are distinguishable from the American species, though the Yangtze valley species (*L. modestum*) and the northernmost form (*L. septentrionale*) approach it rather closely. The difficulty had been with the lack of ample series and the want of conspicuous characters on one hand, and the general conservatism of the scincid lizards on the other.

The related groups in the two areas may be examined more in detail. The Cryptobranchidae are represented by *Cryptobranchus* in eastern North America and by *Megalobatrachus* in China and Japan. The differences between the two genera are not great, but neither are they widely distinct from a fossil species (*Andrias scheuchzeri*) in the Oligocene of Europe. It is evident that the group is an ancient one and that the close resemblance between the three forms is due to conservatism rather than to a recent origin of the group. In general structure, and in the fact that fertilization is external, the group is distinctly primitive. The newt fauna (*Triturus*) of the two areas is poor when compared with that of Europe, where the newts have undergone an expansion comparable with that of the Hynobiidae in eastern Asia and the Ambystomidae in North America. The latter, and the still more specialized American family Plethodontidae are unrepresented in Asia, and the extraordinary development of the American salamander fauna is strikingly shown by the presence of two highly peculiar types, the Sirenidae and the Amphiumidae. The family Proteidae being represented by the widespread *Necturus,* the North American fauna, in the southeastern United States, exhibits seven of the eight families of salamanders. The Hynobiidae, which are both primitive and generalized, scarcely reach Europe, and have developed five genera and twenty-two species in eastern Asia.

The frogs and toads common to the two areas belong to the genera *Bufo, Hyla,* and *Rana.* None of these genera are confined to the two areas nor, indeed, to the Holarctic Region, and thus they do not contribute evidence of special relationship between the faunae. The wood-frog group, with a circumpolar distribution, belongs rather with European and west American faunae than with the Chinese and east American.

One of the most striking resemblances between the two faunae lies in the development of the freshwater turtles. The more aquatic Testudinidae, perhaps best distinguished as the family Emydididae, have a most striking distribution. Entirely absent from Australia, from Africa with the exception of a single species, and with only a pair of outlying forms in South America, the group is primarily Holarctic. The inequality of their distribution in both Eurasia and North America has already been mentioned. Three species, *Clemmys leprosa* and *caspica* and *Emmys orbicularis,* are found in Europe, and a single *Clemmys* (*C. marmorata*) on the Pacific slope of North America. In contrast with this sparse population, eastern Asia has five genera and a dozen species (including four *Clemmys*), and eastern North America eight genera and twenty-three species (*Clemmys* with three species). *Clemmys* and *Emys* appear to be the only genera that appear in both hemispheres, and the family accordingly presents the aspect of an old and well differentiated group. The parallel between the Old World and the New World faunae is continued by the fact that the emydine forms overflow into southeastern Asia and into Central America. The soft-shelled turtles (*Trionyx*) range into the Oriental and African regions, and do not belong to the restricted faunal element under consideration.

The allied forms of lizards involve some of the most striking and abundant forms. The genus *Leiolopisma* has already been mentioned. The genus *Eumeces* is differentiated into numerous species in the two areas, and in some measure parallels the development of the emydid turtles. It presents a close parallel to the interesting distribution of the limbless *Ophisaurus,* the "glass snakes," whose five species are found in north Africa, central and southeastern Europe, the eastern Himalayas, southern China, and southeastern North America. Both *Eumeces* and *Ophisaurus* are absent from western Europe, and *Eumeces* is only sparingly represented in western North America, the glass snake not at all. Their distribution is a curiously peripheral one with relation to the more strictly Holarctic fauna.

The genera of snakes in common are *Natrix, Opheodrys, Elaphe,* and *Agkistrodon.* Of these *Opheodrys* is strictly confined to the two areas. Both *Elaphe* and *Natrix* are sparingly represented in Europe but absent from Pacific America. Both, however, have their chief centers of speciation in China and southeast North America, and thus strikingly parallel the distribution of the Emydidae. *Agkistrodon* reaches south Mexico on the American Continent, and Java in the Orient, and thus requires mention again in connection with the more shadowy faunal resemblance between the East Indies and Central America.

The only remaining reptiles that effect the present problem are the two species of *Alligator,* one widespread in the southeastern United States, the other with an extremely limited range on the lower Yangtze. This genus is well represented by fossil species, in the Tertiary with an especially instructive species from the middle-Miocene of Wyoming (*A. thompsoni* Mook). The living alligators are evidently relicts of a widespread late Mesozoic and early Tertiary Holarctic range. All of the group for which there is fossil evidence (spoonbill, sturgeons, alligators, cryptobranchids) combine to sug-

gest that the existing resemblances between eastern Asia and eastern America are all that remain of a wide-spread Holarctic fauna of an earlier period, and one in numerous respects peripheral to the Holarctic fauna of the present day.

The elements of the two principal faunal resemblances discussed in this paper are rather strikingly contrasted:

Western	*Eastern*
Numerous species in common	No species in common
Common genera of highly specialized forms e.g. *Hydromantes*	Common families of primitive types (Alligatoridae, Cryptobranchidae)
Single species and genera	Families and genera differentiated into numerous genera and species
[1] General poverty of fauna, at least in amphibians and reptiles	A rich herpetological fauna

[1] Compare Gray, 1878.

It is an essential part of Matthew's theory of distribution that there have been successive migration waves spreading outward from the northern land masses. The east American-east Asiatic common element appears to represent one of these great faunal waves, in accordance with this theory, and one which largely antedates the Tertiary mammalian evolution. The European-west American relation depends upon dispersals conditioned by the relatively recent Ice Age.

Traces of still earlier faunal waves or, perhaps, in part, of the earliest phase of the east Asiatic-east American wave in question, are to be seen in the faunal element common to Central America and the East Indies. The Central American fauna presents certain obvious relations with eastern North America (*Chelydra, Pseudemys, Ophisaurus*), which are paralleled in the Orient by an east Asiatic element in the fauna of the East Indies (emydid turtles, *"Ophisaurus"*). The persistence of the remarkable lizards of the family Helodermatidae with *Heloderma* in Mexico and the southwestern United States and *Lanthanotus* in Borneo forms a striking parallel to the distribution of the tapirs, but is probably to be referred to a much earlier date. The snapping turtles with *Chelydra* in Central America and *Devisia* in New Guinea fall into line with this element. The Oriental and the Central American species of the genus *Geoemyda* (Emydidae) afford a clear example of this peripheral wave. The species of pit-vipers of the genus *Trimeresurus* in the Orient and in tropical America are also in agreement, but their relations with the more primitive but more northern *Agkistrodon* complicate the question of the age of their dispersal. It is evident that the peripheral distribution of primitive forms postulated by Matthew may be obscured by the fact that the retreat of a group before its more advanced competitors may be an ecological instead of a geographic one. Primitive forms are often left behind by more advanced ones, a part of whose superiority may rest on a greater adaptability to climatic conditions, with capacity for rapid spread.

The parallel between the southward extension of the two faunae is a striking one when tabulated:

Central American		Southeast Asiatic	
Chelydra	*Ophisaurus*	*Platysternon* and *Devisia*	
Geoemyda	*Leiolopisma*	*Geoemyda*	*Leiolopisma*
Crocodylus	*Elaphe*	*Crocodylus*	*Elaphe*
Trimeresurus		*Ophisaurus*	*Trimeresurus*

The distribution of the crocodilians falls satisfactorily into successive waves of dispersal. The earliest is represented by the South American caimans, whose broad snouts and heavy dermal armor seem to make them the most primitive living members of the order. The true crocodiles have two primitive genera in equatorial Africa and primitive short-snouted forms in India and Central America, and there is some paleontological evidence to show that these forms are an early and distinct phase of the dispersal of the more modern, longer-snouted species, all of them belonging to the genus *Crocodylus,* which has two African, four Oriental, three Australian, and four tropical American species. The genus is completely absent from eastern and central South America, where the caimans hold their own. The widespread American *C. acutus* just reaches Florida, while the still more widely ranging *C. porosus* reaches south China. The alligators fall into line as a fourth wave of dispersal but not, I believe, as the last, in spite of their more northern range. They are plainly "hanging relicts" [2] of the Mesozoic dispersal waves, obviously later than the caimans but earlier than the crocodiles.

There is a general agreement of the South American, Australian, and African faunae in certain primitive elements, among which may be mentioned lung fishes; leptodactylid frogs; pleurodiran turtles; the more primitive groups of snakes and lizards; and the marsupials (absent from Africa). The list might be greatly extended among invertebrate groups; it includes forms about whose ancient or primitive nature there is no question; and where there are paleontological records, these point to an early Mesozoic or at least pre-Cretaceous dispersal. These primitive faunae are probably the accumulated remnants of repeated dispersals in the late Paleozoic and early Mesozoic, i.e. from the "Holarctic" fauna of those early ages.

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2 Schmidt, 1943: 248. In this list *Chelydra, Ophisaurus, Leiolopisma,* and *Elaphe* are found also in southeastern North America, and with the substitution of *Platysternon* for *Chelydra,* the same genera are represented in China.

A Notable Frog Chorus in Brazil

By Bertha Lutz

DURING an excursion to southern Matto Grosso in November of 1945, I had an experience unique in my twenty odd years of frog collecting in Brazil. It was the right season for frog breeding aggregations, but the weather was quite unfavorable during most of the trip. The rains had begun but soon stopped, and all the way to the Paraguay River, Joaquim Venancio and I had to work very hard to secure a representative collection. We were traveling on an Inspection Train, kindly put at our disposal by the Director of the Northwestern Railway of Brazil, and on the way back we telegraphed ahead to every station asking about weather conditions. On November 21, from Miranda, near the edge of the Pantanal (the Brazilian equivalent of the Gran Chaco, but on the eastern side of the Paraguay River), we received our first piece of good news, namely: "This afternoon, it rained enough for the water to remain standing." We proceeded to Miranda at full speed. Hardly had we pulled into the station at 8 P.M., when we donned hip boots and made for the lagoon a few hundred meters away. After a few seconds walk we heard a great roar of frog voices quite unlike any frog chorus I had ever heard before, and more like a cataract, or a huge and vocal crowd. As we approached we began to distinguish the different calls of several species. A few minutes later we found the performers in action.

The pool was only a few tens of yards long and wide and rather shallow. There must have been several thousand frogs, belonging to some 12 species, participating in the concert. The sheet of water must be semi-permanent, at least, as we could hear a big *Pseudis,* which is entirely aquatic, and next day we found some planorbid snails. The pool was surrounded by a fence of stakes, about a yard and a half high, some of them hollow. On every one of the stakes we touched there were frogs sitting, mostly large hylas, much like *H. venulosa,* but with a different pattern in the iris and a much less irritating secretion than those of what we suppose to be *H. venulosa* in the Maritime Range. Smaller hylas of the *Hyla rubra* complex, referred to *H. nasica* Cope by Lorenz Müller and others, of a very small species like *H. elongata* Lutz, but differing from Müller's picture of *H. nana,* were sitting on the backs and heads of the large fellows on top of the stakes. The sight of tree frogs peering out of holes in the hollow stakes, as if from windows, which I had seen but once farther along the pantanal, was repeated again and again. These frogs were of the *Hyla rubra* group and gave a call like the signals of Morse Code. We raced each other towards a noise which can be best compared to an automobile horn touched off by a short circuit in a confined space. I won, and got a *H. venulosa,* which had already entered the water. We could also distinguish the *rrenk, rrenk, rrenk,* of *Hyla spegazzinii,* one of the most common species in the Pantanal.

The toads were in courtship mood. *Bufo paracnemis* Lutz, distinguishable from *B. marinus* by the presence of a large gland on the leg and the occurrence of mottled males, was there, and also *Bufo granulosus* Spix, which is a common form from northwestern São Paulo to Paraguay. We witnessed a

tournament between three large males of *B. paracnemis,* for a single and patient female. One was sitting on her back, one was trying to climb up from in front of her head and the third attacked from the rear. When the one in front failed to dislodge the cavalier he viciously tried to pull the whole team under. The rear side strategist was the most successful. He dislodged the others and prepared to ride off to some quiet spot, provided there was one, on his bride. Being in need of good specimens, I regret to say we bagged them. Meanwhile, little *Bufo granulosus* shrilled away like Brazilian night-watchmen with whistles, the little round, glaucous vocal sac, standing out like a ball, in the middle of the ferruginous gular area.

The paludicolas, which were the principal objective of our trip, were represented by three different species. *Physalaemus fuscomaculatus* behaves exactly as Budgett described from the Paraguayan Chaco. It floats on the water, distended to a huge size, alternately inflating the enormous vocal pouch and the abdomen, giving out a cry which sounds like OO-AAH . . . OO-AAH . . . OO-AAH . . . lowering the pitch on the second syllable which is considerably longer. When grasped it deflates immediately. Several males float near each other and vie with one another in producing their plaintive contribution to the vocal symphony.

Eupemphix nattereri is generally considered conspecific with *P. fuscomaculatus,* but is really quite different. It is larger in size and the dorsal pattern figured by Steindachner is constant. It is vinaceous and quite different from the gray and black of *Physalaemus fuscomaculatus.* Our amateur helpers distinguished them quite easily and called *E. nattereri* the "speckled frog" from the Vetiver blue dots on a black ground on the concealed parts of the thighs. It sits close to the edge and is less gregarious. The call is a staccato note something like: quôô/quôô/quôô . . . without any inflection. There was also a third, smaller species somewhat like *Physalaemus gracilis,* which has a more southern distribution and is montane in southeastern Brazil. The smaller species had a repeated cry rather like the miaouing of a kitten. On returning to Rio we found that it corresponded to the description and especially the picture given by Steindachner of *P. albonotatus.* Natterer's comparison of the voice is also fairly close. The two last named species were both described from Matto Grosso, though from farther north.

In the middle of the lagoon a large and inaccessible *Pseudis,* probably *paradoxa,* gave out its crackling call, while at the edge of the pool we found a number of very handsome *Hypopachus incrassatus* with conspicuous black ventral vermiculation sometimes extending to the olive green back and a few dull yellow spots. Two other microhylids were also there, *Elachistocleis ovale,* with yellow mottling on a gray ventral surface and a bright yellow to orange longitudinal stripe on the thigh and innerside of the legs, and a small white-spotted one, probably *Chiasmocleis albopunctatus* Boettger.

Just by repeated stooping we gathered well over 200 specimens of all these different species of frogs. There were few females present but on the way back we met a *Physalaemus fuscomaculatus* wending her way down the road to the pond. Next morning hens and chickens were picking up frogs on the edges of the water. A few masses of froth had been left by the palu-

dicoline frogs. In the evening we collected a number of small hylas, which were now calling from plants near the water. We also got a fine series of *Eupemphix nattereri*, including a few females caught swimming across a very large puddle blocking the road to the males ensconced at the edges. We pulled out of Miranda at 10 P.M., after a rather fruitless effort to find mated pairs of the frogs heard singing. The chorus droned on though it did not seem quite so voluminous as the evening before, just after the rain.

MUSEU NACIONAL, RIO DE JANEIRO, BRAZIL.

Notes on Reptiles from the State of Washington

By THOMAS H. LEWIS

REPRODUCTION AND BEHAVIOR OF YOUNG IN *Gerrhonotus*

THE process of reproduction and behavior of the young of various species of the lizards of the genus *Gerrhonotus* (Plate I, A) have received the attention of a number of observers, and the occurrence of both viviparity and oviparity within the genus has been described by Fitch (1935: 13, 27, and 1938: 422). The writer has had the privilege of observing in the laboratory the more northern and less studied *Gerrhonotus coeruleus principis* (Baird and Girard). Specimens were freshly caught adults, taken in the vicinity of Seattle, Washington. The following are my abbreviated notes.

An adult female, dissected April 26, 1941, had 3 eggs 2.9 mm. in diameter and 3 eggs 1.0 mm. in diameter in the right ovary, and 2 eggs 2.9 mm. in diameter and 5 eggs 0.5-1.0 mm. in diameter in the left. The larger eggs are covered with fine blood vessels.

April 26–28, 1941, vigorous mating activity was observed in several laboratory cages during day and evening. Average air temperature 27.5° C. Details essentially as described by Vestal (1940: 51), and Svihla (1942: 54).

BROOD I.—On Aug. 15, 1940, at 11:12 A.M., six young were discovered in a cage with an emaciated and listless female. The young lizards were Cinnamon Brown above, black with fine white speckling laterally. The ventral surface was Light Gull Gray. They were active, and made active tongue thrusts.

At 12:30 P.M. The young lizards had removed themselves from the open sand floor of the cage and were found curled up in the damp soil beneath clumps of grass.

At 10:00 P.M., Aug. 16, the young were photographed against a background of white muslin tightly stretched over a wooden frame tilted at an angle of 60° from the horizontal. The lizards showed a strong and persistant negative geotropism. They move upward in rushes of 6–7 inches, forward movement being accompanied by a lateral thrashing motion.

On Aug. 24 two of the young lizards stalked a wingless fly in their cage, moving the head slowly from side to side in a nervous manner as they approached their prey. One seized, chewed and swallowed the insect.

BROOD 2.—On Aug. 22, 1940, at 9:00 A.M., seven young *Gerrhonotus* were found in a cage containing an adult female and two adult males. No young had been observed in this cage on the previous day. Coloration as previously described with additional mid-dorsal spotting with black. At any given temperature of day or night, the newborn lizards were more active than the adults. They crawled over the lethargic adults when frightened, or when moving about cage without discernible external stimulus.

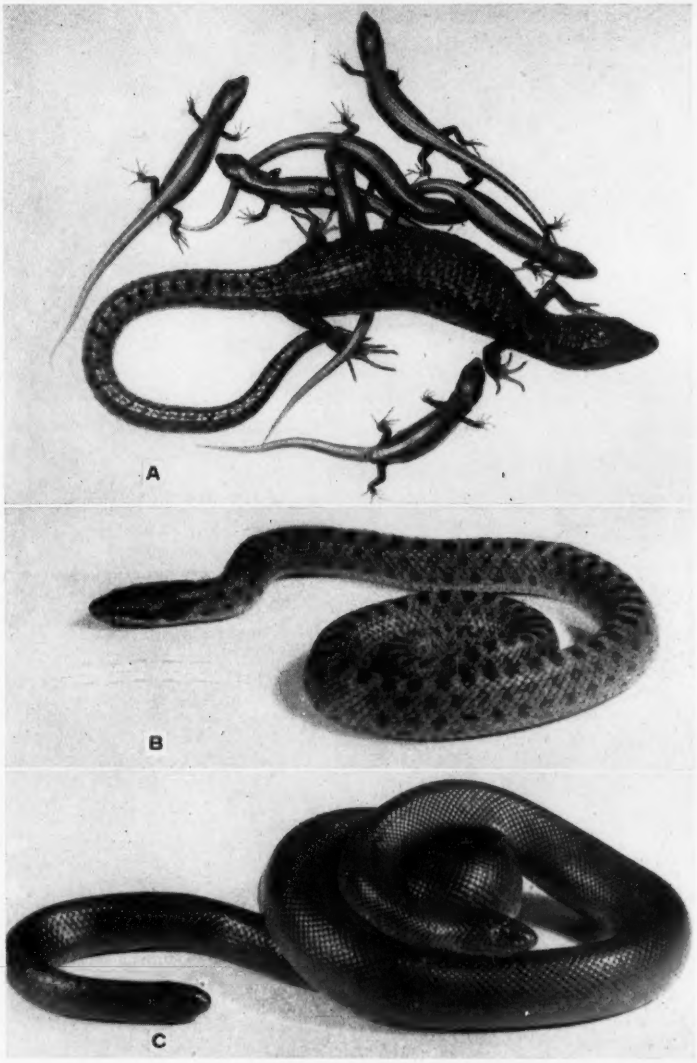
BROOD 3.—On Aug. 29, 1940, at 7:15 A.M., a cage with a single adult female was observed to contain a newly born lizard. At 5:00 P.M., five newborn were present. The young move very rapidly, using the body-tail "wriggle." They are almost impossible to weigh and measure.

BROOD 4.—On Sept. 5, 1941, at 1:15 P.M., during a one hour gap in observation, four active young *Gerrhonotus* appeared in a cage that previously had contained only the adult female. One of the newborn was still enclosed in a sac of remarkable thinness and delicacy, much like the film of a soap bubble. The sac was damp, and grains of sand and particles of vegetable debris clung to it. This sac adhered to the middle third of the tail of the female, who ran about the cage dragging it. When it dropped off, the fetus almost immediately pierced the membrane with its head. The young lizard lay exhausted, with its eyes open. In about 50 seconds it began to breathe, to move its head and tongue, and then to crawl out of the sac. Particles of sand adhered to the damp surface of the infant lizard.

The juvenile specimens of this group dashed wildly away from approaching adults. They were also frightened by slight movements of observer. They showed no reaction to loud noises of different pitch. Both adults and young are violently stimulated by light hammer strokes against supports of cage.

At 11:00 P.M., the young lizards escaped the cool temperature of the evening by burrowing under the sleeping adults. On the following day these young were Wood Brown dorsally, with slight black peppering, and ventrally blackish with a few small white spots. The sharply marked lateral bands were black with white peppering. They show negative geotropism when placed on inclined surfaces.

The twenty-two newborn lizards observed, members of four different litters, show moderate variation in color and pattern. The average length is 76 mm. Six specimens preserved on the second or third day after birth



A. *Gerrhonotus coeruleus principis*, mother with new born young; B. *Hypsiglena ochrorhyncha*, specimen from Grant Co., Washington; C. *Charina bottae* from near Seattle, Washington.

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measure from 70 to 74 mm., average 71.5 mm., and have an average weight of 69 grams. Negative geotropism is a prominent characteristic, especially when the individual is on an inclined surface.

Observations on *Hypsiglena ochrorhyncha*

Although poison glands, ducts, or other structures connected with venom production and use in *Hypsiglena ochrorhyncha* Cope (Plate I, B) remain to be demonstrated, and no toxin has actually been demonstrated or isolated, the manner in which this small and little known snake overcomes its prey indicates a venom of rather low virulence, of but minute quantity, and of peculiar physiological properties. The following field and laboratory observations of the effects of *Hypsiglena* bites on *Uta stansburiana stansburiana* (Baird and Girard) may serve to augment in "case-history" fashion the study of the question of venom in *Hypsiglena* by Cowles (1941: 4–6)

While collecting in Grant county, Washington, June 10, 1941, an adult *Uta* was put in a collecting sack containing two specimens of *Hypsiglena ochrorhyncha*. A few minutes later, the lizard was seized by one of the snakes just behind the axilla. The lizard was rescued, but was dead the following morning, and on the succeeding day was eaten by one of the snakes when thrown into its cage. There were no visible wounds, and the lizard's death may perhaps have been caused by venom.

On July 1, 1941, a *Uta* was dropped in a cage containing three specimens of *Hypsiglena*. It was immediately seized by two snakes, one holding it at the axilla, the other at the base of the tail. Both chewed the lizard thoroughly. After three minutes, one snake released its grip and lost interest. The other continued to chew and twist its victim, possibly to imbed the "fangs" to greater advantage. The lizard was periodically passive, with intervals of struggling and kicking. Eight minutes after being first attacked it escaped. Examination showed it to be lethargic, with slow respiration and slow movement of limbs, and that it was unable to right itself. Skin lesions were minimal. When again dropped in the cage it was seized once more and subjected to prolonged chewing. The snake occasionally picked up its prey and carried it bodily about the cage. Sixteen minutes after first being attacked, the lizard was completely limp, and seemed to be dead. It was then swallowed by the snake.

On July 2, 1941, another *Uta* was dispatched in similar fashion.

On July 6, 1941, a female *Uta* was offered to a *Hypsiglena*. The snake immediately struck the right leg of the lizard and moved its grip rapidly to encompass the body at the groin. The chewing movements seem to produce no skin abrasion or subcutaneous contusion. Within three minutes the lizard demonstrated rapid, labored respiration. Five minutes after being struck the lizard showed brief recurrent periods of desperate activity, both in attempts to escape, and in offensive movements. These periods of activity were interspersed with longer intervals of flaccid relaxation during which the eyes were closed, and there was no response to dragging and mauling. At ten minutes, the lizard was even more inert. The respirations were shallower and slower. There were a few spasmodic movements of the head and jaws. At fifteen minutes, the lizard, except for occasional jerky inspirations, appeared to be

dead. At twenty minutes the lizard struggled fiercely, and when this ceased, the tail continued to twitch rapidly. The snake had advanced its grip, by slow shifting and chewing, to the axilla. The lizard's body, although dampened by saliva, showed no open wounds or scale damage through which venom might penetrate. At twenty-eight minutes the snake had obtained a grip on the head of the completely inert lizard, and began to swallow, completing the process fifty-eight minutes later.

On August 19, 1941, a *Uta* was seized on the side of the neck by a *Hypsiglena*. The snake enveloped its prey in several loose coils but did not constrict. The lizard made a few quick struggles, then lay inert. Two minutes later the lizard was flaccid, its legs stiffened, and its eyes closed. Respiration was rapid. In six minutes the snake had the entire neck in its mouth and was chewing vigorously. Respiration of the lizard was still rapid. At seven minutes after the bite, the snake extended the posterior part of its body up the corner of the rough wooden cage, hooked its tail over a projection, and pulled itself and its prey about eight inches up the side of the cage. It lost its grip, fell to the floor of the cage, and disengaged its teeth from the lizard. The snake then moved around the cage for approximately four minutes. During this interval the lizard was inert and without visible respiration. The neck had many superficial lacerations and some blood. The snake returned and seized the lizard, which now began to struggle violently. The snake and lizard rolled about, throwing sand against the walls of the cage. The lizard escaped, ran across the cage, climbed the wall, dropped back, and was removed from the cage for inspection.

On examination it was quite limp, with only occasional feeble movements. Respiration was irregular and very slow. The eyes were closed. Injuries as previously described. After ten minutes the lizard seemed dead, with no respiration, no response to stimulus with a needle, no response to pulling of limbs, massage, opening of eyes or jaws. The wounds on the nape were quite superficial, and a mechanical explanation for the cause of death seems difficult. Forty minutes afterward, the lizard was returned to the cage, and the snake immediately began to swallow it.

These notes serve only to suggest the interest of further anatomical and histologic study of the oral glands and accessory structures of *Hypsiglena*. This most secretive little reptile is an excellent candidate for life history studies by someone who is able to observe it in its natural habitat.

Observations on the Habits of the Rubber Boa

The apparent rarity of the rubber boa, *Charina bottae* (Blainville), in Washington is largely a function of the secretive habits of this snake. Actually, *Charina* (Plate I, C) is often common in localities where it is seldom seen, and its relative abundance is unsuspected by collectors unacquainted with its habitat preferences. In Washington it has been found to inhabit dry, well-drained terrain, and it is distributed through the arid eastern portion of the state and in small areas on the coast where humid rain forests give way to conditions meeting its apparently exacting demands.

In the eastern part of the state I have collected rubber boas in the open yellow pine forests of the Arid Transition Zone. Two specimens were col-

lected near Cle Elum on June 3, 1941 (altitude 2,000 ft., annual precipitation under 30 inches). One was found in the damp mold under a decayed pine log, another beneath a large boulder. These specimens measured 160 and 220 mm.

In the Humid Transition Zone of coastal Washington *Charina* was frequently seen in a large abandoned gravel pit near Seattle. This denuded area was an "island" of dry, stoney soil with a sparse growth of *Lupinus* and *Rubus ursinus* (altitude 40 ft., annual precipitation 36 inches). The surrounding ridges support a very different flora, more characteristic of the Puget Sound Basin, i.e. Douglas fir, *Arbutus menziesii*, and a dense undergrowth, mostly of *Berberis* and *Castilleja*. This "island" is separated from a salt water beach several hundred feet distant by a steep sandy bluff. *Sceloporus o. occidentalis* shares this area with *Charina*, and neither are found in areas that do not closely approach it in character.

In this circumscribed area seven specimens were collected in April and May, 1941. They were always found in the slightly moist spots beneath logs or sheets of scrap metal. At one time three were found under one log. The snakes varied from 140 to 480 mm. in length. Several extensive searches in the heat and dryness of mid-summer failed to yield any specimens.

Often described as failing to feed in captivity, specimens of *Charina* kept in dry cages with sand floors exhibited good appetites. *Mus musculus* and *Peromyscus*, alive or dead, were eagerly eaten. Small specimens successfully dealt with nestling mice. Invertebrates, salamanders and frogs were refused. When a live mouse is placed in a cage, several or all of the snakes begin to stalk it. The mouth is held open throughout the stalk, which may require 20–30 minutes because of the slow movements characteristic of the small boas. The strike is rapid, but is an ineffectual slashing movement of the anterior portion of the body, the lateral component greater than the forward one. Once seized, the prey is constricted in haste by coil upon coil and held until dead. A large mouse occasionally inflicts severe bites before being overpowered. Swallowing is completed while the snake is still a sand strewn ball, head in the center. *Charina* drinks frequently in the laboratory, and lives peacefully with *Pituophis, Coluber constrictor mormon, Sceloporus,* and *Gerrhonotus*.

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Observations on Captive Pilot Black Snakes and Common Water Snakes

By Robert A. Littleford and William F. Keller

FOR a number of years the senior author has been investigating the desirability of various species of snakes as laboratory animals. Particular attention has been given to local species that are relatively abundant so that the problem of obtaining healthy specimens would be reduced to a minimum. In choosing any laboratory animal, certain characteristics such as ease of handling, resistance to disease, time required for caring for the colony, and behavior under caged conditions are factors that must be considered. The choice in this vicinity narrowed down to either *Elaphe obsoleta obsoleta* or *Natrix sipedon sipedon,* which are relatively abundant, easy to obtain during the greater part of the year, and have considerable hardiness and resistance to disease. This paper presents our methods of care, and a general summary of our notes on these two reptiles under laboratory conditions.

Methods of Care

Obviously, there are many satisfactory methods for housing snakes in the laboratory. We do not claim that our method is superior to others, nor that it is particularly original. It was suggested to us in its general outlines by Mr. John N. Hamlet of the U. S. Fish and Wildlife Service, and probably is in use in one form or another by many individuals. Ditmars (1936: 124) suggests the essentials of the method when he states that "[snakes] will live for years in a well-ventilated cage. . . . All the accessories needed are a water pan and rough stone for skin casting."

Our snakes are caged in wooden boxes measuring 3 x 3 x 2 feet. The entire upper foot of the front of the box is made of ¼ inch mesh wire cloth. The top of the box is hinged in three sections and the entire top is fastened to the box by hooks and eyes. The smallest opening thus available measures 1 x 3 feet, and if necessary the entire top may be removed in a few seconds. This type of top also facilitates cleaning, in that it may be removed, giving free access to the entire interior. The floor of the box is bare, with the exception of a pan of water (8 x 3 inches) and a large rock, which serves no useful purpose as far as we are able to determine except that it aids in keeping the individuals apart at the time of feeding.

Each box holds four to eight reptiles comfortably, and the inhabitants have adequate light and air and at the same time are not disturbed by the movement of people in the room, as vision out of the box through the wire front is quite restricted. The boxes are placed on a rack which is raised 18 inches above the floor, thus keeping them away from dampness and drafts and at the same time placing them at a very satisfactory height for use.

A definite routine was established for caring for the snakes, in that once a week they were removed from the cage, weighed, measured, thoroughly washed under the tap, and dried. The cage was cleaned and after the snakes were returned to the cage, they were fed. Whenever one was ready to shed, a moistened cloth sack was placed in the cage, otherwise care was exercised

to keep the cages as dry as possible. No effort was made to stimulate natural conditions, and as nearly as we are able to determine, the artificial conditions have not proved to be detrimental. The cages are kept in a basement room, where year-round temperature variation is between 20° to 25° C.

Considerable care is taken to handle the snakes gently at all times. They are never irritated in any way, they are always lowered gently to the floor of the cage or other receptacle, and visitors are discouraged. The results discussed below have been obtained from a number of snakes observed over a period of years, with particular reference to ten pilot black snakes and five banded water snakes retained during 1945.

Observations

Feeding.—The general results on feeding are presented for *Elaphe* in Table I.

At the beginning of feeding any individual, considerable patience was necessary since the snakes appeared somewhat nervous and apprehensive. Efforts to feed live mice were not successful as the snakes did not have sufficient room, apparently, to maneuver properly, and the mice could escape readily. Therefore, the mice were killed and placed on the end of a wire, which was then drawn slowly back and forth across the case in front of the snake. If interest was shown, the mouse was moved toward the snake until it struck and coiled on the mouse. It was then made to "fight" in order to pull the mouse off the wire, as experience demonstrated that if the mouse was dropped in these initial feedings, it was rarely picked up by the snake and often interest in feeding ceased abruptly. If feeding was not initiated within ten minutes, the snake was not bothered further, but allowed to wait until the following week.

Once feeding was initiated, the snakes would feed as long as mice were offered to them, as many as ten to eighteen mice being taken one after the other before the snake was finished. As this resulted in regurgitation some hours later in some individuals, this procedure was modified and a limited diet supplied instead. After the second or third feeding, the snakes came to expect food and then seized one mouse right after the other, quite often grasping one while the tail of the preceding one was still protruding from the mouth.

Considerable individual differences in feeding behavior were noted as the snakes became used to receiving food regularly. By the third feeding, they were able to distinguish between dead and live mice. They refused to coil or strike on dead mice, simply removing them from the wire, but struck swiftly and aggressively at live ones. Some (Nos. 1, 2, and 7), the larger ones in the group, learned within two weeks to take food held in the hand. They would reach up to the top of the cage and take either live or dead mice from the fingers. Number 2, after a period of a month, no longer exerted itself to get food, but accepted mice as they were offered without moving other than to make slight, and probably necessary, alterations in its position.

In general, it was more difficult to get females to feed than males. Female snakes appeared more apprehensive and wary of the caretaker and generally required patient effort to get them adjusted. They would stop feeding, even

in the middle of the swallowing process, on the entrance of strangers, or if something were dropped in the room or the adjacent corridor. Noise did not seem to bother them.

Of considerable interest is the fact that the snakes stopped feeding during August and September. During this period, food was offered weekly as usual, but none of the *Elaphe* evidenced any interest in it. Their weight did not show any significant decline, they remained fat and in evident good health, and they moved around the cages. After shedding in the latter part of September, they again showed interest in food and have fed regularly every week since that time. The amount of food consumed during the winter months has been much less than that taken during the late spring and summer and the values given in the table represent all of the food that the individual snakes required.

Efforts to initiate feeding on cold-blooded forms such as frogs, toads, worms, etc., have been unproductive. In a few instances, the snakes would evidence interest, but no effort was ever made actually to feed on any of these forms.

Feeding of *Natrix,* in contrast with *Elaphe,* was an easy job, as they ate regularly and required no particular care. Frogs, salamanders, and toads were placed in the cage every week and during the summer quite often twice a week. In cases of necessity small pieces of fish were placed in the cage. All the food was consumed readily and no effort whatever was required in the feeding process. The *Natrix* continued to eat regularly during August and September when the *Elaphe* did not feed. Toads offered as food afforded an interesting observation. The first toad fed to a *Natrix* was invariably grasped by the hind legs, as it usually grasps a frog. The toad was immediately dropped and remained untouched for anywhere from fifteen to thirty minutes. After that time it was regrasped by the head. One *Natrix,* No. 11, made the mistake only once, even when a time interval of three weeks separated the offers of a toad. The others had to relearn from experience on each occasion.

A very noticeable difference in the feeding behavior of *Elaphe* and *Natrix* was in the behavior of the individual snakes toward each other. The *Natrix* paid little attention to each other or to any *Elaphe* that might be in the cage with them. If there was not any more available food, the snake would search the entire cage thoroughly, finally settling down in a corner. At no time was any attempt made to take food from another snake. The *Elaphe* by contrast had to be fed in such a way that each individual in the cage finished at approximately the same time, otherwise they would attempt to take food from one another. Size apparently was not a factor in this behavior, as a snake 40 inches long did not hesitate to grasp a mouse being swallowed by a snake of 70 inches in length.

Skin Shedding.—The dates of shedding for the fifteen snakes observed during 1945 are given in Table II.

In the case of *Elaphe,* it will be observed that all of the snakes shed their skins at approximately the same time in June and September. Snake No. 9, which was collected on September 8, also shed during the same period as did

TABLE I

WEIGHT OF FOOD IN GRAMS EATEN BY *Elaphe o. obsoleta*, JUNE–DECEMBER, 1945

Number	Total Length	Feeding Dates[1] and Amount Consumed																							
		6/7	6/15	6/23	6/30	7/6	7/13	7/20	7/27	8/2	8/10	10/2	10/9	10/16	10/23	10/30	11/6	11/13	11/20	11/27	12/4	12/18	12/25
	(inches)																						
1	65	344	R[2]	238	200	250	225	156	R	120	R	R	115	151	98	50	25	R	96	97	84	46	37
2	64	300	98	R	166	175	200	200	286	92	R	24	26	56	24	57	38	R	87	36	15	100	98
3	50	R	R	R	100	100	225	R	250	100	98	120	R	56	87	96	30	25	64	R	75	120	64
4	56	125	R	100	125	130	250	100	R	64	R	52	61	R	50	105	33	25	97	30	75	86	100
5	60	R	R	280	98	250	R	325	100	50	50	R	125	50	74	94	61	20	15	30	65	72	30
7[3]	58										R	125	R	68	100	98	42	53	50	20	40	17	25
8[4]	47											50	R	50	60	31	56	78	20	29	36	80	100
10[5]	47											169	180	72	65	40	R	R	120	30	45	160	180

1 Note break in date from 8/10 to 10/2, see text.
2 R = refused food.
3 Collected 8/5/45.
4 Collected 8/10/45.
5 Collected 10/1/45.

those that had been in the laboratory since early June. Comparing this table with Table I it is evident that the individual snakes did not feed the week previous to shedding and the failure to shed during the period from the middle of July until the end of September is correlated in time with the period of August and September when these snakes did not feed. However, it is not implied that the lack of feeding was the reason for the failure to molt as we have observed that many individual snakes shed their skins, some rather regularly, without feeding. No. 6, for example, shed in June, July, September, and January without feeding at all during the last recorded skin shedding. No. 9, which was collected in early September, shed in September, December, and January, and so far has refused to feed. It is doubtful whether any specific correlation could be established between feeding and shedding of the skin.

Stabler (1939: 227–229) reported careful records on the molting of 21 captive snakes over a considerable period. The three specimens of *E. o. obsoleta* observed by him showed an interval between shedding of 1.2, 1.8, and 2.5 months, respectively. The two specimens of *N. s. sipedon* showed a similar period of 1.9 and 1.4 months between shedding. The conditions under which his snakes were kept differed from ours in that they were allowed to undergo a resting period from October to April. The individual *obsoleta* that was kept for a year under similar conditions to ours averaged a shedding every 1.7 months.

There are certain correlations of our data with those of Stabler. He observed that the snakes under observation commenced to feed in the spring 2.5 months before the first vernal shedding. In this locality that would bring the spring shedding around the middle of June, or of approximately the period when all of our snakes shed. A similar correlation exists between the shedding observed by us in all of the snakes during the latter part of September and Stabler's observation that feeding continued on the average 0.8 months after the last fall shedding. During the fall and winter months our snakes have fed regularly but have required far less food than they did during the summer. It appears that the temperature of the room in which they have been kept during the winter (approximately that of summer) has prevented them from undergoing a typical resting period, but that while they have remained quite active, certain aspects of winter rest have not been entirely eliminated. It is possible that the shedding in January on the part of most of the individuals represents an "anticipation" of the normal spring molt. We are of the opinion that shedding, in part at least, is determined by temperature and rate of metabolism of the snakes.

From October through January, the single *Natrix* retained has continued to shed regularly at monthly intervals. Immediately after the molt on September 15, this specimen gave birth to 44 young, 42 living and 2 dead. The *Elaphe* with the exception of Nos. 9 and 10 failed to shed during the period from October to January.

The duration of the shedding time has varied from 18 to 36 minutes, with an average of 27 minutes in those cases in which shedding appeared to be normal. *Elaphe* No. 1 required 5 days to complete the process in June, possibly as the result of insufficient moisture.

The behavior of the individual snake after shedding varies. *Elaphe* No. 2 remained totally immersed in water for a period of 4 days after shedding in June, and for 16 hours after shedding in September. *Elaphe* No. 3, after each of the three molts, remained inside the damp cloth sack where it crawled to shed for 6 to 9 hours. No. 9 of the same species remained in water for 18 hours after shedding in September, for 23 hours after shedding in December, and for 3 days after the January shedding. The others showed preference for a corner of the cage some distance from the water pan.

The *Natrix* were rarely in the water at any time and failed to show any particular need for it after shedding. In two instances they remained in the water for 3 hours after molting; in all others they became quite active immediately afterwards and moved constantly around the cage.

TABLE II

MOLTING DATES OF *Elaphe* AND *Natrix*, JUNE, 1945–JANUARY, 1946

Number	Genus	Total Length	Dates of Shedding							
			June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
		(inches)								
1	*Elaphe*	65	25			15				
2	*Elaphe*	64	30			10				
3	*Elaphe*	50	27	25		14				
4	*Elaphe*	56	22			15				23
5	*Elaphe*	60	19	20		21				28
6	*Elaphe*	58	16	15		24				25
7[1]	*Elaphe*	58				24				30
8[2]	*Elaphe*	47				19				
9[3]	*Elaphe*	70				21			19	30
10[4]	*Elaphe*	47						16		24
11	*Natrix*	32	14	16	19	15	19	18	21	22
12[5]	*Natrix*	24	12	17	20					
13[5]	*Natrix*	29		16	20					
14[5]	*Natrix*	22	15	19	22					
15[5]	*Natrix*	30	20	25	26					

1 Collected 8/5/45.
2 Collected 8/10/45.
3 Collected 9/8/45.
4 Collected 10/1/45.
5 Released after August molt.

OTHER BEHAVIOR.—It is difficult to evaluate objectively the behavior of an animal such as a snake, as we are quite liable to "read into" the reactions of the snake some response that makes sense to the observer. With this qualification, certain aspects of behavior will be mentioned.

Considerable initial difference in temperament was noted in the *Elaphe*. Some individuals were quite phlegmatic upon capture and retained a docile behavior after capture. Others were quarrelsome, would strike without provocation and required a period of from two weeks to a month to get accustomed to cage conditions. Similar observations were made on 15 specimens hatched in the laboratory. Some of these were quiet, others were easily irritated, and some would strike and vibrate the tail as soon as anyone approached them. Differences in initial temperament had no effect on feeding as far as could be determined. Originally the snakes were kept in glass front

cages, and this appeared to make them more difficult to handle. Their disposition was nervous as long as they were in these cages. After being moved to the larger and more private cage, they became quiet and in some the nervous behavior disappeared.

At the end of a two-week period, all of the snakes kept by us were able to recognize either of us and paid little attention to being handled or examined in any way. Strangers were detected almost at once, and the snakes evidenced this by vibrating the tail rapidly on the floor of the cage. At intervals they would strike either toward the open top of the cage or at the wire front. After about a month in captivity, they confined their reactions to strangers to restless behavior or at most to slight vibrations of the tail. At the end of six weeks they could be lifted out of the cage without attempting to strike, with the exception of No. 2, which still strikes or makes feints at striking every time it is removed from the cage.

The females are generally more nervous than the males, and even though they submit readily to handling, they appear more tense than the males. The smaller the snake, the more likely it is to require a long period to adjust itself to conditions. The large 70-inch specimen has never attempted to strike since being brought into the laboratory. The small specimens, even after several months of confinement, are more nervous than the larger specimens.

Sudden jars, dropping of objects in the corridor or the room provoke an instant response that can best be described as wariness. Individuals moving around the room fail to provoke any response whatsoever.

Water snakes always are pugnacious individuals and all of our specimens fit this description. When first caged, they are intractable and extremely difficult to handle. They use their anal scent glands at every opportunity, and the specimen still retained in the laboratory continues this behavior whenever it is picked up. They fail to show any recognition of either of us, strangers do not bother them, and in all respects they appear oblivious of their surroundings. Most of our *Natrix* were released simply because they were uninteresting and difficult to handle.

Both *Elaphe* and *Natrix* have been caged together, and the system is very successful. Either group may be fed without interference or interest on the part of the other. New individuals may be introduced at will to any of the cages without creating any excitement. During June, the introduction of a new individual *Elaphe* to a cage containing the same species provoked a "dance-like" behavior on the part of all the snakes. They would rub the anterior part of the bodies together or across each other. This behavior was continued for as long as 2 or 3 hours beginning and ending at intervals. Efforts to feed the snakes during June was often interrupted by such behavior for period of from 15 to 30 minutes. The actions were probably basically sexual, but were carried out regardless of whether the individuals were of the same or opposite sexes.

Discussion

On the basis of the above observations, the authors have formed rather clear cut opinions as to the desirability of either of these forms for laboratory use, and any individual would have to make his decision based on the type

of investigation that he had in mind, and the facilities available for caring for the reptiles.

As far as time is concerned, *Natrix* requires the least amount of time and attention. The food utilized by this species is readily available or may easily be procured. *Elaphe* requires more time as far as feeding is concerned, and the source of food would, in many cases, be more of a problem. We have been fortunate in that the Department of Zoology maintains colonies of mice and rats, and therefore food is always available. The complicated method of feeding that we have used for *Elaphe* may be unnecessary, in that eventually these snakes would avail themselves of food placed alive in the cage. This method, in our experience, has led to fights, injury from the mice, and an increase in nervousness and apprehension on the part of the more nervous individuals.

Elaphe are far more easily manipulated than *Natrix*, a factor that must be considered if the research involved requires frequent handling of the snakes. We do not agree with Ditmars (1936: 232) that *Elaphe* cannot be trusted, as all of our specimens may be completely trusted within the limitations of their differing temperaments. Our experience has been more in accord with that of Conant and Bridges (1939: 58) who found that *Elaphe o. obsoleta* fed well and were quite satisfactory as captive specimens.

For laboratory investigation that requires regular handling of the snakes, we are of the opinion that *Elaphe* is just as satisfactory a laboratory subject as any of the king snakes, for example. At the same time we recognize that other species may be just as suitable. Roth (1942: 224–33) apparently found *Elaphe guttata* and *Pituophis sayi sayi* quite adaptable as laboratory forms. In regard to the latter species, the senior author observed several years ago that specimens of this species fed well and were quite docile in captivity. Excellent results have also been obtained with several species of *Thamnophis*. On the other hand, if the type of work involved required a minimum of handling of the specimens and time was limited, *Natrix* would be an ideal form as it requires the very minimum of attention to keep in excellent condition.

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Department of Zoology, University of Maryland, College Park, Maryland.

Herpetological Notes

GRAPTEMYS GEOGRAPHICA (LE SUEUR) ADDED TO HERPETOFAUNAL LIST OF GREAT SMOKY MOUNTAINS NATIONAL PARK.—On May 19, 1944, *Graptemys geographica* was detected for the first time in the Great Smoky Mountains National Park area when Maryann Stupka observed a specimen in Abrams Creek, approximately one-half mile above the point where the creek joins the Little Tennessee River. The turtle had been dead several days, but its markings were unmistakable. The specimen was a male, its measurements are as follows:

Head length:	47.6 mm. = 1⅞″	Carapace width:	127.0 mm. = 5″
Head width:	28.6 mm. = 1⅛″	Plastron length:	138.1 mm. = 5 7/16″
Head height:	23.8 mm. = 15/16″	Plastron width:	101.6 mm. = 4″ (bet. P and A)
Tail length:	41.3 mm. = 1⅝″	Shell height:	47.6 mm. = 1⅞″
Carapace length:	155.6 mm. = 6⅛″		

This specimen is preserved in the herpetofaunal collection of Great Smoky Mtn. National Park, catalog number GG-1.—JOHN THORNTON WOOD, *Antioch College, Yellow Springs, Ohio.*

MEASUREMENTS OF A GIANT *PSEUDOTRITON MONTANUS MONTANUS* LARVA FROM GREAT SMOKY MOUNTAINS NATIONAL PARK.—The larvae of *Pseudotriton m. montanus,* according to S. C. Bishop (Handbook of Salamanders, 1943: 386), attain a length of at least 72 mm. but may transform when considerably smaller. In reporting on the largest larva of this species he had had the opportunity to examine, E. R. Dunn (The Salamanders of the family Plethodontidae, 1926: 289) published measurements of a Smith College specimen from Raleigh, North Carolina, with a total length of 68 mm. If these larvae are large for the subspecies, Willis King (Amer. Midl. Nat., 21 (3), 1939: 557) collected a very unusual specimen which he identifies as a "fully grown larva" which was found in the old spring house at Mount Sterling, eastern extremity of Great Smoky Mtns. National Park, at 1,600 feet elevation. The larva mentioned by King, according to the herpetofaunal catalog of the Park, was collected by him on March 4, 1936, near Chestnut Branch, which runs east into Big Creek inside the park boundary near Mount Sterling Post Office, Haywood County, North Carolina. The author collected in this area April 23-26, 1946, but failed to locate the described location. No additional specimens of this species were collected.

The larva collected by King is so much larger than any other published records that neoteny seemed possible but an examination of the internal reproduction organs indicated the specimen was sexually inmature. Measurements are as follows:

Total length:	127.0 mm.	Body length:	59.5 mm.
Head length:	15.0 mm.	Tail length:	52.5 mm.
Head width:	11.8 mm.		

Gills measured from 7.0–9.0 mm. in length. The distal half of the tail was vertically compressed, and, at a point 30 mm. posterior to the mid-point of the vent the tail had a vertical height of 14.0 mm. Maximum body thickness was 9.5 mm., only ⅔ of the height of the caudal "fin."

Preservation made it impossible to determine how the ground color compared with that of adults in life, but the dorsal spot pattern was very similar to that of an adult (total length: 102 mm.) from the park.

Although Bishop reports the species reaches a maximum length of 178 mm., the average total length of twelve adults of both sexes from Virginia and North Carolina was 126 mm., slightly smaller than King's larva. The general body proportions compare closely with an adult made from Raleigh, North Carolina, reported by Bishop, although the modifications of head parts and tail are dissimilar.—JOHN THORNTON WOOD, *Antioch College, Yellow Springs, Ohio.*

ADDITIONAL OHIO RECORDS OF *PLETHODON RICHMONDI.*—*Plethodon richmondi* has been reported from only two localities in western Ohio, "Eden Park, Cincinnati, Hamilton County," by Netting and Mittleman (1938, Ann. Carn. Mus., 27: 287–293), and "Glen Helen, Yellow Springs Township, Green County," by the author (1945, Copeia: 49). Field work has disclosed areas in Montgomery and Champaign counties where the species also occurs.

Montgomery County.—On April 18, 1944, Cpl. H. J. Walter, Miss Irene Neher, and the author collected 5 specimens from beneath small slabs of limestone lying on the talus slope of the deeply wooded ravine below Sunderland Falls, Butler Township. All specimens came from the west slope, and were found in the lower half of the elevation, in a dry habitat. Numerous *Plethodon c. cinereus* and *Eurycea l. longicauda* were collected in this same habitat.

On April 21, 1944, Cpl. H. J. Walter collected 6 specimens in an abandoned limestone quarry located at the junction of Chambersburg Road and Bellfontaine Road, a locality approximately 5¼ miles southeast of Sunderland Falls, in Wayne Township, 963 feet above sea level.

These two locations are both in the NW area of Montgomery County, approximately 52 miles NNW of Cincinnati; and 16 and 11 miles WNW of Yellow Springs, respectively.

Champaign County.—On April 15, 1945, the author collected one specimen from beneath a decayed tree trunk at the base of a slope located on the west side of Kiser Lake (known as "Mosquito Lake" on the St. Paris quadrangle, U.S. Geodetic Survey Map), Johnson Township. This locality, 1060 feet above sea level, is 78 miles NNE of Cincinnati, 26 miles NNW of Yellow Springs, the most northern point from which *Plethodon richmondi* has been reported in western Ohio.—John Thornton Wood, *Antioch College, Yellow Springs, Ohio.*

EGG LAYING AND DEVELOPMENT OF THE PILOT BLACK SNAKE.—On June 5, 1945, a 50-inch female pilot black snake was collected and brought into the laboratory. The snake was quiet and easily handled. She consistently refused food and shed her skin on June 27. On July 2 this specimen laid 12 eggs, 4 of which adhered to each other. The eggs were otherwise scattered over the bottom of the cage, and the snake paid no further attention to them. The measurements of these eggs are shown in Table I, A.

TABLE I

Measurements of Two Egg Clutches of the Pilot Black Snake

A			B		
No.	Weight (g.)	Size (mm.)	No.	Weight (g.)	Size (mm.)
1.	15	42 x 22	1.	14	42 x 24
2.	12	36 x 23	2.	13	42 x 22
3.	15	39 x 23	3.	12	40 x 23
4.	15	42 x 23.5	4.	13	42 x 23
5.	15	46 x 23.5	5.	14	44 x 22
6.	15	42 x 22	6.	15	45 x 21
7.	11	39 x 22	7.	13	42 x 23
8.	15	44 x 23.5	8.	13	39 x 23
9.	15	38 x 23	9.	13	44 x 20
10.	15	42 x 23	10.	14	44 x 24
11.	15	43 x 22.5	11.	14	42.5 x 24
12.	15	41.5 x 23	12.	13	42 x 23
			13.	14	47 x 22

The eggs were placed in a pan of moist shavings and kept in a basement room where the temperature varied only slightly from 20° C. On August 15, the average weight of the eggs was 18.0 grams. One was opened at this time and the embryo was found to be developed past the stage where the eye was a well defined structure. The eggs had

an average weight of 22.15 grams on September 1, and a fully developed embryo still attached to the yolk was removed from an egg examined on that date. In this particular egg, the yolk occupied half of the area and weighed 12.5 grams; the snake weighing 8.17 grams. When the embryo had been out of the egg for 7 minutes, definite respiratory movements could be observed. The eyes were opaque at first, but had cleared at the end of 15 minutes. The individual was sensitive to touch, pulling away sharply when touched with a probe. It lived for an hour and a half immersed, with the exception of the head, in physiological salt solution. At the end of that time, respiration ceased and the specimen was considered dead. It was male, total length 246 mm., tail length 42 mm.

Three of the eggs hatched between midnight September 16 and 8:00 A.M. September 17; 1 hatched at 12:30 P.M. the same day; another during the night of September 17; and the sixth egg hatched at 11:00 A.M. on September 18. The remaining 4 eggs were opened on the 26th, when it was found that 3 were infertile. A snake was removed from the fourth, making a total of 9 fertile eggs of the original 12. The average weight of the 7 young snakes was 11.35 grams; the lightest weighed 9.5 grams, the heaviest (5 individuals), 12.0 grams. The total length ranged from 267 mm. to 324 mm., with an average of 305 mm.

Another female *Elaphe,* 58 inches in total length, also collected in early June, shed on July 15 and laid 13 eggs on July 17. These were also scattered on the floor of the cage, with 3 of them adhering to each other. The weights and measurements of these eggs are shown in Table I, B. These eggs were kept like the first lot and examined at intervals. The average weight on August 15 was 17.5 grams. By September 1, they had increased in weight to an average of 20.5 grams, and on September 26 they averaged 23.6 grams in weight. Eight snakes were hatched from these eggs; 2 on September 30, 1 on October 2, 4 on October 3, and 1 on October 5. The other eggs falied to hatch; 4 did not show any signs of development, and 1 became infested with mites and was destroyed. The 8 snakes averaged 12.0 grams in weight at birth. Total length ranged from 297 mm. to 331 mm., with an average of 308 mm.

The fifteen snakes were placed together in a roomy cage and observed for frequency of molting and feeding. All 15 shed for the first time between October 11 and 16, previous to being fed. They were measured immediately afterward, and none had increased in size. Beginning on October 20 they were fed one or two day-old baby mice at weekly intervals. Because of the lack of time, it was not possible to feed the snakes individually, and naturally the more aggressive individuals obtained the greater part of the food. The amount of food utilized by the snakes was prodigious and gives some index of the extensive amount that must be consumed under natural circumstances. The number of mice eaten weekly varied from 30 to 45, a total of 527 mice being fed in a period of 3 months. The actual weight of the mice was 563 grams.

All the snakes shed between November 14 and 19, with an average length increase of 22 mm., and again between December 15 and 22, this time with an average length increase of 26 mm. over the previous period. Shedding occurred again between January 16 and 20, and by this time considerable growth increase had taken place. The longest individual measured 545 mm. in total length; the shortest 343 mm. The average for the 15 snakes at this time was 403 mm., 5 of the snakes measuring 407 mm. In 3 months the snakes increased in length by about one-third; the greatest gain, 221 mm., being made by No. 1 of Lot A, which measured 324 mm. originally and 545 mm. in January.

The increase in linear dimension was not accompanied by an increase in weight, probably the result of insufficient food. As a matter of fact, none of the snakes had actually increased their weight, and 3 individuals weighed from 1.5 to 2.5 grams less than they did when hatched. All measurements here given for total lengths were made by extending the snakes on a metal rule graduated in millimeters. The eggs were measured by means of a Vernier caliper, and the weights were obtained from a spring balance calibrated in ½ grams. It is planned to continue observations on this group of snakes until they reach maturity.—ROBERT A. LITTLEFORD and WILLIAM F. KELLER, *Department of Zoology, University of Maryland, College Park, Maryland.*

STATUS OF THE MANGROVE TERRAPIN.—The nomenclature of the diamondback terrapins has recently been the subject of considerable comment. Some of this has been decidedly ill-considered, but the central proposal suggesting acceptance of an older

name for the terrapin of the Atlantic Coast is evidently justifiable. It is not to this question that the present notes relate.

Because of an almost complete lack of specimens from the southernmost tip of Florida it has hitherto not been possible to evaluate the relationship between the two nominal species of *Malaclemmys, M. terrapin* on the Atlantic Coast and *M. pileata* along the borders of the Gulf. Siebenrock (1909, Zool. Jahrb., Suppl. 10: 472), evidently more or less intuitively, arranged the five known forms in a connected taxonomic series, and in this he had a half-hearted following. For the most part, however, zoologists have persisted in regarding the diamondbacks as making up two distinct species separated from each other by the peninsula of Florida. On the Gulf Coast *M. pileata macrospilota* has not been definitely known from south of Charlotte Harbor, while on the Atlantic side of the peninsula definite records for the group have terminated even farther north. Evidently this apparent geographic gap has fostered the impression that two distinct stocks are involved. In this respect the following points seem to warrant mention.

1. The Atlantic and Gulf terrapin populations meet in southern Florida. I have seen specimens from (or at) Sebastian, Indian River, Card Sound, Boca Grande Key (lower Keys) and Cape Sable.

2. The only structural feature employed by Hay (1904, Bull. Bur. Fish., 24: 19) in dividing the genus into two species was the distal expansion of the central keels in the *pileata* group. These curious bosses are superficially arresting but are variable and apparently quite erratically so, both in this genus and in the closely related *Graptemys*. They appear to have no great value as a taxonomic character, however intriguing their historical implications. In the Atlantic terrapins the tubercles begin to appear in mid-peninsular Florida and are as well developed in some individuals from Sebastian as in typical *macrospilota* from the Gulf.

3. In 1906 Fowler (Proc. Acad. Nat. Sci. Phila., 58: 112, pl. 4) described *M. littoralis rhizophorarum* [1] on the basis of a single specimen from Boca Grande Key (ANSP No. 16, 570), and I find this to be a recognizable form. Although intermediate geographically, and to an extent morphologically, between *macrospilota* and *centrata* the population has

Fig. 1. Female specimen of *M. terrapin rhizophorarum* from Card Sound, Florida. Photograph by Dr. Albert Laessle.

characters that are fairly constant throughout a considerable range in tropical Florida. It has the bulbous central keels (Fig. 1) of the Gulf terrapins but approaches *centrata* in lacking the yellowish (transparent) centers in the dorsal laminae, which so strongly differentiate *macrospilota*. Usually it may be distinguished from *littoralis*, which it fortuitously approaches most closely, and in the synonymy of which Siebenrock placed it, by a moderately consistent decoration of black bands along the lower marginal and some of the plastral sutures.[2]

1 From *Rhizophora*, the genus of the red mangrove.

2 In the original description Fowler stated, I believe inadvertently, that the black bands are located on the sutures of the marginals of the *carapace*. This slip of the pen, combined with the unlikely zoogeographic situation implied by the trinomial used, perhaps accounts for the failure of the race to find recognition.

The following key will differentiate a majority of specimens of each of the six populations:

1. Keels of centrals not expanded distally 2
   Keels of centrals with terminal expansions 3
2. Sides of shell divergent posteriorly.....*M. terrapin terrapin*
   (Cape Cod south to Cape Hatteras)
   Sides of shell nearly (or quite) parallel.....*M. terrapin centrata*
   (Cape Hatteras south to southern Florida)
3. Laminae of the carapace with conspicuous light centers...*M. terrapin macrospilota*
   (West Coast of Florida from the Panhandle southward)
   Laminae of the carapace without (or with only vague or desultory) light centers. 4
4. Sutures of lower marginals and of plastrals frequently bordered with black; shell strongly oblong .....*M. terrapin rhizophorarum*
   (Florida Keys)
   Sutures not regularly black-bordered; shell more oval 5
5. Carapace uniform in color, usually black or dark brown; top of head and upper lip dark .....*M. terrapin pileata*
   (Louisiana to the Florida Panhandle)
   Carapace uniform or with concentric markings, usually light brown; upper lip and top of head usually white .....*M. terrapin littoralis*
   (Coast of Texas southward, possibly to the Yucatan Peninsula)

—A. F. Carr, Jr., *Department of Biology, University of Florida, Gainesville, Florida,* and *Escuela Agricola Panamericana, Honduras.*

NOTE ON THE ARBOREAL FEEDING HABITS OF THE DESERT IGUANA.—Although published reports have stated that the desert iguana (*Dipsosaurus dorsalis dorsalis*), otherwise known as the northern crested lizard, has been observed climbing into shrubs and bushes in order to feed on the foliage and blossoms, the really considerable arboreal ability of the animal had never been noticed by myself until recently, though I have been familiar with the lizard in the field for some twenty years.

Thus it was particularly interesting to me (and also instructive as to collectors' mental blind spots) that on April 28, 1945, I observed dozens of these large and presumably conspicuous lizards feeding on the blossoms of creosote bushes growing along the edge of the Palm Springs-Indio Highway near Cathedral City, California. Without a doubt, this activity had been going on under similar conditions in all the previous years of my visits.

Throughout many years of collecting experience on the desert, it has been my invariable habit to search for these lizards in the early morning hours when they are basking or during late afternoon when the animals are similarly engaged in absorbing heat by lying on the ground in the direct sunshine. With a little practice it is easy to develop the ability to see these almost sandy-white lizards against their similarly colored background. However, as temperatures rise, the lizards retreat to shade, from which they make short sorties for insects, or to the flowering plants nearby, or in pursuit of each other during the mating season.

The moving lizards are easy to locate, although the bulk of the population, composed of animals resting in the shade, is difficult to see, but practice enables the collector to continue his activities until the combined air and ground temperature result in lizard body-temperatures of approximately 43° C., about half a degree below the maximum observed to date. Apparently this temperature represents the thermal ceiling for this species.

At and above thermal conditions producing body temperatures of 43° C. the lizards retreat to their cooler underground shelters, but between the basking period and retreat underground, the collector frequently notes the complete disappearance of the lizards. Such a disappearance was observed on the above mentioned trip, and a search of the creosote bushes (*Larrea divaricata*) was initiated in order to see if the lizards were possibly feeding in the presumably cooler locations within the foliage. Within three-quarters of an hour more than a dozen lizards were observed at heights ranging from a few inches to 5 feet 6 inches above ground, all of them apparently engaged in feeding on the yellow flowers, or merely resting in shade and partial sunshine.

A desert iguana, *Dipsosaurus d. dorsalis*, 5 feet 6 inches above ground in a creosote bush, *Larrea divaricata*.

It is interesting that in the presumably cooler location, several feet above ground, the temperatures of lizards ranged from about 43° C. up to 43.4°. This high temperature may be accounted for in part by the fact that the lizards were in partial sunshine; and their departure to cooler underground retreats may have been delayed by the presence of the observer.—R. B. COWLES, *Department of Zoology, University of California, Los Angeles, California.*

RECORDS OF THE SNAPPING TURTLE FROM NEW MEXICO.—On September 3, 1944, while talking to a pair of negro fishermen on the bank of the Pecos River about 15 miles northeast of Roswell, Chaves County, New Mexico, I picked up the remains of a snapping turtle, *Chelydra s. serpentina* Linnaeus. The fishermen called it a loggerhead turtle and stated that it was not very common in the river but that it was more so in a creek near Roswell, where it was said to attain a weight of forty to fifty pounds. Although I have seined most of the major streams in the eastern half of the state, this is the first time I have seen this species in New Mexico. The snapping turtle has not, apparently, been previously recorded from the state. A few hours before, a brief glimpse of a strange looking turtle in a pool beneath the bridge had aroused speculations as to its identity. Judging from what was seen, it was, in all likelihood, a snapping turtle. An hour of seining in the pool for fish failed to yield the turtle.

I am indebted to Mr. Adrey E. Borell of the U. S. Soil Conservation Service for further New Mexican records of this turtle. He took three specimens in July, 1945. One was captured in an irrigation ditch just south of Santa Rosa in Guadalupe County, in the Pecos drainage, and two in a semi-permanent tributary of the Mora River, eighteen miles east of Wagonmound, Mora County, in the Canadian River watershed.—WILLIAM J. KOSTER, *University of New Mexico, Albuquerque, New Mexico.*

THE ROBBER FROG IN NEW MEXICO.—A robber frog, *Eleutherodactylus latrans* Cope, was discovered while taking down my tent twelve miles northwest of Carlsbad, Eddy County, New Mexico, on September 5, 1944. Together with a *Cnemidophorus*, which escaped, it had apparently sought shelter under the tent during a violent storm in which about 1.6 inches of rain fell in fifteen hours. The region for several hundred yards about the location is a grassy plain with a scattering of shrubs. The canyon of the Pecos is about half a mile distant, and a small rocky hill projects above the plain about a third of a mile away. Dr. A. H. Wright of Cornell University has kindly checked my identification.

This specimen differs in color from most of the descriptions available. Notes made from the specimen shortly after preservation in formalin, when the natural colors were little changed, are as follows: most of dorsum greenish, darkest on head and neck; venter plain white; upper jaw whitish with vertical green bars; a double whitish line extending across the anterior part of the interorbital area; an irregular whitish line, extending most of the distance between the interorbital lines and the interscapular region; body with numerous dark green spots, the more posterior ones faintly outlined with whitish; band across back between the arm insertions and fore-limbs ivory; a greenish bar on the wrist and forearm and a faint one on the upper arm; hind limbs lighter green than the back with darker green bars, these more or less outlined with lighter.—WILLIAM J. KOSTER, *University of New Mexico, Albuquerque, New Mexico.*

DELAYED HATCHING IN THE BOX TURTLE.—Delayed hatching in the snapping turtle has been reported (Toner, G. C., COPEIA, 1940: 265), but the writer has seen no reports of similar occurrences in the common box turtle, *Terrapene carolina* Linnaeus. Pope (Turtles of the United States and Canada, 1939) says, "In nature the young escape from the eggs in approximately three months, but incubation periods ranging in length from 69 to 114 days are on record."

On July 17, 1939, a recently captured female laid five eggs. These were kept under as favorable conditions as possible, and with the advent of freezing weather were moved, without disturbing the soil in which they were buried, into the house to a location where the temperature ranged from 40 to 60° F., never dropping to the freezing point. A moist condition of the soil was maintained. On March 10, 1940, it was decided that no hatching could be expected, so the eggs were dug out and examined. Four were spoiled, containing no trace of embryos. The fifth contained an apparently normal embryo, with active cir-

culation and able to move its appendages. A yolk sack with a diameter of 15 mm. was present. It would therefore appear that an incubation period of over 230 days was not sufficient for this individual, although the temperature was above freezing at all times and averaged very much higher.—E. C. DRIVER, *Smith College, Northampton, Massachusetts.*

PLETHODON WELLERI FROM FLAT TOP MOUNTAIN, NORTH CAROLINA.—While studying a collection of salamanders from western North Carolina, the writer found one specimen of *Plethodon welleri* Walker from Flat Top Mountain, Yancey County, North Carolina, eleven miles southeast of Erwin, Tennessee. This specimen was collected May 29, 1945, by J. C. Nicholls. According to his field label, the salamander was found under a moss-covered rock in a "field" of broken rock in a cold, shady beech-birch forest on the very summit of the mountain. Two specimens of *Plethodon metcalfi* Brimley were collected from the same locality.

Only two localities have been known for this species up to this time; Grandfather Mountain, North Carolina, and White Top Mountain, Virginia. This record extends its range approximately thirty miles to the southwest.

A comparison with a series of sixteen *P. welleri* from Grandfather Mountain shows that the Flat Top individual has a more conspicuous spotting of the venter. In itself, this may mean nothing, but it is of interest that this observation parallels that made by Walker (1934, COPEIA: 190) on specimens from White Top Mountain, Virginia.

I wish to thank Dr. Sherman C. Bishop for confirming the identification of Weller's salamander.—RICHARD C. SNYDER, *Department of Zoology, Cornell University, Ithaca, New York.*

Ichthyological Notes

A COLLECTION OF FISHES FROM THE STOMACHS OF SHARKS TAKEN OFF SALERNO, FLORIDA.—The stomachs of 200 sharks, 167 *Carcharinus milberti* (Valenciennes) and 33 *Carcharinus obscurus* (LeSueur), taken off Salerno, Florida, in 16 to 18 fathoms, were opened for examination by the writer during the period from June 30 to July 4, 1943. The area in which the sharks were taken is near the inshore limit of the Gulf Stream and is subject to strong variable currents which may have either a northerly or southerly direction. There were two unusual features about the catch. The sharks were quite cold to the touch when brought to the dock in the early afternoon and none of the sharks had empty stomachs. A large proportion of the sharks taken on set lines in Florida are found with empty stomachs. Empty stomachs are not the rule in catches of the tiger shark, *Galeocerdo cuvier* (LeSueur), where con-

siderable quantities of undigestible material are included in the stomach contents. Inquiry among the fishermen brought the information that cold sharks had been taken before but that the condition was by no means normal.

The stomach contents included groupers in the 5 to 10 pound range and many of these were relatively undamaged by digestion. These fish as well as the more numerous smaller forms had been swallowed entire. The facts suggest the possibility that the sharks took advantage of a cold water upwelling which stunned or killed a portion of the bottom-dwelling fish fauna.

The sharks were all adults and therefore in two size groups according to species. The *C. obscurus* were in the 9 to 11 foot range and the *C. milberti* in the 6½ to 7½ foot range. The larger sharks had, in general, eaten the larger fish. Nearly all the groupers were in *C. obscurus* stomachs while that species had eaten few octopus and crabs. Nearly all of the *C. milberti* contained some octopus remains as well as occasional crab remains. The octopus were not identified but all were of small size with greatest spread of tentacles less than 3 feet. The crabs noted were *Hepatus* sp. and *Calappa* sp.

The fish that were in condition for identification were sorted on the spot and only representative individuals were saved for more careful examination. A list of the forms identified follows:—*Trachinocephalus myops* (Forster), most abundant form encountered; *Citharichthys macrops* Dresel, many present; *Syacium papillosum* (Linnaeus), few; *Epinephelus morio* (Cuvier and Valenciennes), many; *Mycteroperca venenosa* (Linnaeus), few; *M. microlepis* (Goode and Bean), several; *Acanthurus bahianus* Castelnau, several of large size, about 12 inches; *Scorpaena grandicornis* Cuvier and Valenciennes, one 15 inches long, several smaller; *Rissola marginata* (DeKay), many; *Pseudupeneus maculatus* (Bloch) many; *Pseudopriacanthus altus* (Gill), one 7 inches long; *Callechelys* sp., several; *Gordiichthys* sp., several.—STEWART SPRINGER, *Box 983, Homestead, Florida.*

TARPON IN THE PACIFIC.—It is well known that *Tarpon atlanticus* (Cuvier & Valenciennes) has found its way through the Panama Canal to its Pacific terminus. I have observed them many times in the little Rio Grande, which flows into the Canal between the locks at Miraflores and Balboa. They ascend in numbers with the tide until stopped by the dam at Miraflores. Their "rolling" on the surface is apparently not necessarily associated with feeding, as often at such times they refuse any kind of bait.

Their habit of breaking water often makes them readily noticeable in rivers where they occur. They very commonly ascend many rivers debouching into the Atlantic in Panama.

Dr. Samuel F. Hildebrand suggests that the tarpon found in Gatun Lake and Miraflores Lake are born somewhere in the Atlantic Ocean, and that they use the locks as a passageway in both directions (The Tarpon in the Panama Canal. Scientific Monthly, March, 1937). He found no indication that they breed in either of these lakes or their tributaries.

Tarpon are adventuresome enough to make a rather complicated journey through six lock chambers, two lakes, and a canal to reach the Rio Grande, but apparently they have not as yet included any of the rivers emptying into the Pacific in their itinerary.

In 1942, 1943 and 1944, I made seven trips to the mouth of the Pacora River, some 20 miles east of the Pacific terminus of the Canal. I never observed anything that resembled a tarpon. I have also been on several trips to the mouths of the Caimito and Peraquette rivers, about 10 and 12 miles respectively west of the Pacific terminus of the Canal. I observed no tarpon there. At all of these points I carefully questioned the native fishermen, and found no reason to believe that any of them had ever seen a tarpon in any of these rivers.

Over 30 years have elapsed since tarpon first had access to the Pacific, and though it is possible that they eventually may become established there, at the present time there is no evidence that such has occurred. All of those seen in the Rio Grande and at the Pacific seawater end of the Canal may be migrants from the Atlantic.—PAUL L. SWANSON, *RFD 2, Polk, Pennsylvania.*

Reviews and Comments

THE AMPHIBIANS OF OHIO: PART I, THE FROGS AND TOADS. By Charles F. Walker. Ohio State Archaeological and Historical Society, Columbus, 1946; 1–109, 15 pls., 28 text figs. $1.00.—The publication of Dr. Walker's "Amphibians of Ohio" has long been awaited, and the recent appearance of Part I—the frogs and toads—fully measures up to the high standard that had been anticipated. Few indeed are the state herpetological reports that have been based upon such a wealth of material and so many detailed observations. The Ohio State Museum alone contains in excess of 6,000 amphibians from the Buckeye State, the bulk of them assembled by our author. It was my pleasure to accompany Charles Walker on a great many field trips when we were collecting together in Ohio, and I can attest to the meticulous care with which he recorded his data and of his unending desire to learn everything possible about his chosen subject. His extraordinary knowledge of the geology, botany, and zoology of his native state has enabled him to summarize the ecological relationships of Ohio's amphibians with a skill and acumen that may well be the envy of all but the most versatile naturalists.

The present volume includes the introductory matter for the "Amphibians of Ohio" as a whole, but the bulk of its pages are devoted to the Salientia. Fourteen species and subspecies of toads and frogs are definitely known to occur in the state. The treatment of each is in accordance with the following general plan (subtitles used in the book are herewith capitalized): Identification—a brief statement of diagnostic characteristics; Description—a highly detailed summarization of external anatomy, coloration, and pattern; Measurements; Sexual Dimorphism; Tadpole—anatomy and pigmentation of the larval frog; habitats, habits, and ecology (without benefit of subtitle); Distribution in Ohio; Range (in general); Locality Records—a detailed list arranged by counties and including the museum catalogue numbers of all preserved specimens; General References; Ohio References. Accompanying the discussion of each species is a map on which the Ohio localities are plotted. There is a key for the identification of adult frogs and toads, and another key for the identification of tadpoles—insofar as that is possible. Many of the fine photographs obviously were taken in the field. Drawings, pointing out details of diagnostic value, embellish the two keys.

Herpetologists will probably be most interested in the distribution patterns, the excellent discussions of habits and habitats, and the careful and thoroughly adequate descriptions. Certainly, future monographers of the tailless amphibians will find much of permanent value in Dr. Walker's treatise. Naturalists living in Ohio have now, for the first time, an adequate account of one of the more important groups of vertebrate animals. There is only one major omission in the volume that seems regrettable. It would have helped the reader to visualize general distributions if a small inset map showing the complete range of each form had been included.

After reading this book, all students of natural history will eagerly look forward to the appearance of the companion volume on the salamanders.—Roger Conant, *Philadelphia Zoological Garden, Philadelphia 4, Pennsylvania.*

WRITING THE TECHNICAL REPORT. By J. Raleigh Nelson.—McGraw-Hill Book Company, New York, 1940: XV + 371. $2.50.—The aim of this volume is to demonstrate how to design and construct a report to meet particular requirements. The book is ingeniously and copiously illustrated with examples, accompanied by a running commentary. Although intended primarily for students and young people beginning their profession, it should nevertheless prove of great value to those numerous older workers who still have difficulty in writing reports.—L. A. Walford, *U. S. Fish and Wildlife Service, Washington, D. C.*

EDITORIAL NOTES AND NEWS

Western Division Meeting

THE 1946 meetings of the WESTERN DIVISION, American Society of Ichthyologists and Herpetologists, held at Reno, Nevada, June 18-19, consisted of one symposium and one day of presented papers. The second half of this session was held jointly with the Western Society of Naturalists.

The symposium comprised a discussion on Pacific tunas. ALBERT W. HERRE presented a paper on the commercial tunas of the Pacific and their known distribution, FRANCES N. CLARK outlined the tuna fisheries of the eastern Pacific, and WILBERT W. CHAPMAN presented the problems facing the American tuna industry.

Eight papers read at the general session included "Correlation between fish distribution and hydrographic history of Nevada," by CARL L. HUBBS and ROBERT R. MILLER, "The fishery resources of Brazil." by GEORGE S. MYERS, "Irregularities in the latitudinal distribution of fishes and temperature along the Pacific coast," by CARL L. HUBBS, "The 1946 grunion runs at La Jolla," by BOYD W. WALKER, "Evolutionary aspects of the osmotic pressure of the blood of fishes," by ROBERT C. MILLER, "The amphibian fauna of Brazil," by GEORGE S. MYERS, "Contribution to the natural history of the Oregon red salamander," by CHARLES A. REED and LESLIE MCKAY, and "Similarities between certain west coast and Central American salamanders," by WILLIAM A. HILTON.

BOYD W. WALKER was awarded the prize of $25 for the best student paper read in the ichthyological field.

Officers of the Western Division for the ensuing year are: President, RAYMOND B. COWLES, University of California at Los Angeles; Vice-President, GEORGE S. MYERS, Stanford University; Secretary-Treasurer, FRANCES N. CLARK, California State Fisheries Laboratory, Terminal Island.—FRANCES N. CLARK, *Secretary*.

Summary of the 1946 Meeting

THE twenty-sixth annual meeting of the AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS was held in Pittsburgh, from Tuesday, April 16, through Thursday, April 18.

Sessions of April 16

THE convention opened with registration in the Bird Hall of the Carnegie Museum at 9:00 A.M. PRESIDENT SCHMIDT called the first session to order at 10:10 A.M. and appointed the PRIZE AWARD COMMITTEE, E. R. DUNN, JOSEPH R. BAILEY, and JOHN R. DYMOND. After a brief, cordial welcome by DR. O. E. JENNINGS, Acting Director of the Carnegie Museum, a telegraphic expression of welcome from DR. A. AVINOFF, Director Emeritus, and announcements by the SECRETARY, the following papers were presented:

1. **The herpetological collections of the Carnegie Museum**—M. Graham Netting.
2. **The inheritance of color pattern in *Eleutherodactylus ricordii planirostris***—Coleman J. Goin.
3. **A taxonomic extrapolation**—Arnold B. Grobman.
4. **Growth and variation in *Plethodon wehrlei***—R. D. Hamilton.
5. **Remarks by a cold-blooded vertebrate editor**—Karl P. Schmidt.
6. **Some supposed cases of mimicry in salamanders**—Sherman C. Bishop.

Those in attendance braved a chill wind in order to be photographed at 12:30 P.M. by MR. ARTHUR SWOGER, prominent wildlife photographer. This was followed by luncheon in the Carnegie Institute Cafeteria.

The afternoon session was called to order at 2:15 P.M., with PRESIDENT SCHMIDT presiding, and 70 persons present for the reading of the following papers:

7. **Confirmation of overwintering in painted turtle hatchlings**—Norman Hartweg.
8. **Notes on the home ranges, populations, and relative abundance of some Maryland snakes**—William H. Stickel.
9. **Studies on growth of tagged *Bufo***—Edward C. Raney and Ernest A. Lachner.
10. **Some aspects of reproductive physiology in reptiles**—Herman Rahn.
11. **Ichthyological and herpetological collections and students in South America**—Joseph R. Bailey.

Governors' Meeting

THE BOARD OF GOVERNORS assembled at 8:05 P.M. in Hotel Webster Hall with PRESIDENT SCHMIDT presiding. Following the roll call (22 Governors and 8 invited guests present), the SECRETARY read messages of greeting from 10 absentee governors. Following the reading and approval of the 1942 minutes, the PRESIDENT appointed the following committees: *Nominating*—JOHN R. DYMOND, E. C. RANEY, and COLEMAN J. GOIN; *Resolutions*—CLIFFORD H. POPE and MILTON B. TRAUTMAN. The 288 new members added to the rolls between April 1, 1942, and March 31, 1946, were duly elected to membership. Due to the long hiatus between meetings, the terms of 30 Governors had expired, 10 expired at this meeting, and only 10 continued in office until 1947. The following were elected: *Class of 1948*—JOSEPH R. BAILEY, ROGER CONANT, RAYMOND B. COWLES, MYRON GORDON, WILLIAM A. GOSLINE, III, WILLIAM J. HAMILTON, JR., NORMAN HARTWEG, WILLIAM C. SCHROEDER, E. H. TAYLOR, MILTON B. TRAUTMAN; *Class of 1949*—R. M. ANDERSON, CHARLES M. BOGERT, ROLF L. BOLIN, WALTER H. CHUTE, FRANCIS N. CLARK, H. K. GLOYD, A. S. HAZZARD, WALTER L. NECKER, MARGARET STOREY, LIONEL A. WALFORD; *Class of 1950*—SHERMAN C. BISHOP, CHARLES M. BREDER, JR., FRED R. CAGLE, WILBERT M. CHAPMAN, E. R. DUNN, CLAUDE W. HIBBARD, CARL L. HUBBS, L. M. KLAUBER, GEORGE S. MYERS, LEONARD P. SCHULTZ, CHARLES F. WALKER; *Class of 1951*—REEVE M. BAILEY, D. D. DAVIS, ROBERT R. MILLER, JAMES A. OLIVER, EDWARD C. RANEY, HOBART SMITH, WILLIAM H. STICKEL, F. H. STOYE, ARTHUR SVIHLA, LOREN P. WOODS. The SECRETARY announced the deaths of six Honorary Foreign Members since the 1942 meeting. The distinguished colleagues lost by death were four ichthyologists, J. R. NORMAN, JACQUES PELLEGRIN, C. TATE REGAN, and SIR ARTHUR SMITH-WOODWARD, and two herpetologists, MAJOR STANLEY S. FLOWER and WILLY WOLTERSTORFF. After discussion of prospects to fill the vacancies thus created, the following were unanimously elected Honorary Foreign Members: for ichthyology, L. F. DE BEAUFORT, FERNANDO DE BUEN, PAUL CHABANAUD, and S. L. HORA; for herpetology, G. F. DE WITTE and NICÉFORO MARIA. The SECRETARY reported a gain in the number of Life Members in spite of the deaths of THOMAS BARBOUR, WILLIAM T. BROUGHMAN, and RALPH ELLIS. On March 31, 1946, the Society had 19 fully paid Life Members and 4 partly paid Life Members. On this date the Endowment Fund amounted to $2436.70 (cash and securities) and the Special Gift Fund totaled $2100.00. The Board approved the action of the TREASURER, who made the customary 15 pound annual donation to the *Zoological Record* during the war years. The TREASURER was empowered to increase the Society's gift for the 1945 *Record* to 20 pounds. The proposal of CARL L. HUBBS that a REVOLVING RESEARCH FUND be established was discussed and approved. The PRESIDENT-ELECT, the TREASURER, and a member-at-large appointed by the PRESIDENT, were designated as the committee to raise and to administer this Fund. After some discussion of the editing of COPEIA, the Board voted to establish two additional offices, each to be designated as MANAGING EDITOR. The reason for so doing was the hope on the part of the Board that MRS. GAIGE might be prevailed upon to continue as EDITOR-IN-CHIEF if she had two duly elected MANAGING EDITORS to assist her in such manner or at such times as circumstances warranted. Reprint charges and the possibility of providing some free reprints to authors were discussed. The PUBLICATIONS BOARD was asked to report upon these matters at the 1947 meeting. The rapid exhaustion of the Society's supplies of many back numbers of COPEIA was stressed by the SECRETARY. A motion to restrict the sale of complete sets to libraries was defeated.

The issuance of a new edition of the *Check List* was discussed. In order to start afresh, PRESIDENT SCHMIDT discharged the *Check List Committee* that he had appointed in 1943, but which had never functioned because of wartime interferences. The retiring PRESIDENT was empowered to investigate the matter and to present, in 1947, a plan for preparation of the 6th edition. Similarly, DR. HUBBS was asked to report upon the feasibility of the Society undertaking a check list of fishes.

DR. MYERS' proposal that the Society join with the American Committee for International Wild Life Protection in sponsoring preparation of a book on rare and vanishing fishes was discussed at length, and referred to DR. HUBBS for further discussion with the American Committee. The SECRETARY reported that no invitation for the 1947 meeting had been received. The officers were authorized to act upon invitations received subsequently. All pressing business having been attended to, other matters were deferred to the annual business meeting. The Board adjourned at 11:35 P.M.

Sessions of April 17

DR. CARL L. HUBBS called the morning session to order at 10:10 A.M. for the presentation of the following papers:

12. **Recent discoveries regarding the taxonomy of Californian fishes**—Carl L. Hubbs and W. I. Follett.
13. **Subspecies in Coregonidae**—J. R. Dymond.
14. **On the organization of a demersal fish community**—Herbert E. Warfel.
15. **Two new suckers from Virginia**—Edward C. Raney and Ernest A. Lachner.
16. **An experiment to determine the efficacy of planting hatchery-raised whitefish to maintain or increase a fishery**—William J. K. Harkness (read by J. R. Dymond).
17. **Genetics in ichthyology**—Myron Gordon.
18. **The genetic fixity of differential characters in subspecies of the percid fish, *Boleosoma nigrum***—Karl F. Lagler and Reeve M. Bailey.
19. **Food habits, age and growth of the chubs *(Nocomis)* of northeastern United States**—Ernest A. Lachner.

Following luncheon, the afternoon session convened at 2:15 P.M., with VICE-PRESIDENT GOIN presiding, for the reading of the following papers:

20. **Observations on the ecology and taxonomy of the Amphiumae**—C. L. Baker.
21. **Parallelism in arboreal snakes**—James A. Oliver.
22. **Some remarks on the distribution of *Ancides aeneus***—Arnold B. Grobman.
23. **The range of *Pseudemys scripta gaigeae***—R. D. Hamilton.
24. **Some features of Isthmian distribution**—E. R. Dunn.
25. **Geographic comments on the herpetofauna of Alta Verapaz, Guatemala**—L. C. Stuart.
26. **Reptiles and wild life of the Everglades, 1944-1946**—L. H. Babbitt (Kodachrome movies).

The Annual Banquet of the Society was held in the Imperial Room, Hotel Webster Hall, at 6:30 P.M. The HISTORIAN made history once again by distributing the latest edition of *Ichtherps* to the 110 persons present. The SECRETARY achieved a new high in absent-mindedness; having neglected to provide a toastmaster, he had to serve impromptu, introducing the distinguished guests and presenting PRESIDENT KARL P. SCHMIDT. The presidential address, "The New Systematics, the New Anatomy, and the New Natural History," was so noteworthy for its significance and wit that a spontaneous demand for its publication in COPEIA was vouchsafed by the audience.

Sessions of April 18

PRESIDENT SCHMIDT called the annual business meeting to order at 9:35 A.M. with only a handful of members present. The minutes of the last meeting, already published in COPEIA, were dispensed with.

The SECRETARY reported that 288 new members were added to the rolls during the four years since the previous meeting; 21 members died, 34 resigned, 76 were dropped, and 7 were suspended for want of correct addresses. These losses totaled 138, making a net gain in members of 150 and increasing the total membership to 695. Forty-eight new subscribers were obtained, and 13 subscriptions were cancelled, resulting in a net gain of 35 and increasing the subscription list to 185. In spite of war-time mailing restrictions, the number of copies of COPEIA going to foreign countries increased to a total of 98 copies to 23 foreign countries; Canada leads with 32, England follows with 15, and Brazil is third with 9. Domestic copies total 782, distributed in forty-six states and the District of Columbia; 112 to New York, 105 to California, and 46 to Pennsylvania, the three leading states. The Society still lacks members or subscribers in Delaware and Idaho. The SECRETARY pointed out that the unparalleled increase in membership, growth in sales of back numbers, and frequency of movement of members had so augmented his duties that he could no longer discharge them successfully. He asked that the Society give consideration to the division of the multifarious duties now encompassed by the Secretaryship.

The SECRETARY reported that the Society was financially sound. The TREASURER, arriving belatedly, reported equally informally but less optimistically. He promised a financial statement covering the past few years for publication in COPEIA at a later date.

There were no further reports by officers, and there were no formal standing committee reports. The general inactivity of Society committees was commented upon and suggestions for stimulating them were offered. Criticism of the custom of naming committees from those present at a meeting, rather than from the entire membership, upon the basis of specialized interests, led to the passage of a motion empowering the incoming president to discharge and reconstitute all existing standing committees. Lengthy

discussions of specific committees preceded the following summarized actions: *Committee on Incorporation*—instructed to present a definite recommendation for or against incorporation at the next meeting; *Committee on Nomenclature*—DR. HUBBS agreed to consult with DR. MYERS about the possibility of making the Society's committee a lower court to screen nomenclatorial proposals for transmittal to the International Committee; *Committee on Conservation*—several matters referred for consideration; *Committee on Standards*—helpful discussion without recommendations; *Committee on Indexing Copeia*—MR. NECKER was asked to submit to the committee for its approval a careful estimate of the length and probable cost of the herpetological index, and DR. HUBBS was asked to solicit volunteers to prepare an ichthyological index.

The interim selection of PRESIDENT SCHMIDT as the Society's representative on the Division of Biology and Agriculture of the National Research Council was confirmed. He then reported upon the meeting of this body held in Washington the previous week.

As new business, the desirability of co-sponsoring a volume on rare and vanishing fishes was discussed; it was decided that this matter should be referred to the *Committee on Conservation*. The SECRETARY summarized a telephone conversation with DR. CAGLE, who had requested an expression of opinion upon the desirability of Tulane University assuming the responsibility for HERPETOLOGICA. There was uninhibited discussion and evident division of opinion; the SECRETARY was instructed to apprise DR. CAGLE of the gist of the discussion.

The *Prize Award Committee* announced the awarding of the first prize in ichthyology to ERNEST A. LACHNER and the first prize in herpetology to RODGERS D. HAMILTON, for papers numbered 19 and 4, respectively. No second prizes were awarded.

The *Nominating Committee* presented the following report, which was approved unanimously: JOHN T. NICHOLS and HELEN T. GAIGE, *Honorary Presidents;* CARL L. HUBBS, *President;* ROGER CONANT, MILTON B. TRAUTMAN, and ARNOLD GROBMAN, *Vice-Presidents;* M. GRAHAM NETTING, *Secretary;* ARTHUR W. HENN, *Treasurer;* HELEN T. GAIGE, *Editor-in-Chief;* REEVE M. BAILEY and NORMAN HARTWEG, *Managing Editors;* LIONEL A. WALFORD, *Ichthyological Editor;* KARL P. SCHMIDT, *Herpetological Editor;* and WALTER L. NECKER, *Historian.*

The *Resolutions Committee* offered the following resolutions, which were duly carried:

Whereas, the American Society of Ichthyologists and Herpetologists has sustained an irreparable loss in the death of Dr. Thomas Barbour, who was a member of the Society since its beginning, and an Honorary President,

Be it resolved, that the Secretary be instructed to send to Mrs. Thomas Barbour, on behalf of the members of the Society, a letter expressing deepest sympathy.

Whereas, certain kinds of fishes in the arid parts of the West are confined to extremely limited waters—some to single springs—and

Whereas, these fishes are liable to extinction through the introduction of exotic fishes and through the use of these very limited water supplies for irrigation and for other uses, and

Whereas, some kinds have already been exterminated through such human activities,

Be it resolved, that the American Society of Ichthyologists and Herpetologists at its Twenty-sixth Annual Meeting go on record as favoring the extension of National Park or National Monument boundaries, or the establishment of new areas to be obtained and administered by the National Park Service, for the perpetuation of such threatened species and subspecies of fishes.

Whereas, the support of scientific research by the Federal Government of the United States envisaged in Senate Bill S 1850 offers support and expansion of all research in the United States, and

Whereas, the American Society of Ichthyologists and Herpetologists is alarmed at the delays in passing Bill S 1850,

Be it resolved, that the Society urge favorable action to support this bill.

Whereas, the Carnegie Museum of Pittsburgh, the Pittsburgh Zoological Society, and the Local Committee have acted as hosts at the Twenty-Sixth Annual Meeting of the American Society of Ichthyologists and Herpetologists, April 16 to 18, 1946, and

Whereas, the facilities and entertainment provided gave evidence of the great amount of thought and preparation expended to make the visit of the Society a memorable one,

Be it resolved, that the members of the American Society of Ichthyologists and Herpetologists and their guests here assembled desire to express to the Carnegie Museum, to the Pittsburgh Zoological Society, and to the Local Committee their sincere appreciation and thanks for the effort expended in their behalf.

The meeting adjourned at 12 M.

At 2:15 P.M. the members assembled for a combined program with the American

Society of Mammalogists. DR. E. H. TAYLOR and DR. E. RAYMOND HALL presided jointly during the reading of the following papers:

27. **A punch-card method for organizing specimen and bibliographic data**—Arnold B. Grobman.
28. **Effects of aircraft-distributed DDT oil sprays upon populations of coldblooded vertebrates**—Capt. Earl S. Herald.
29. **The Pan-American convention on nature protection in the Western Hemisphere**—Harold J. Coolidge, Jr.
30. **Reptiles and amphibians in the region of the new Mexican volcano, Paricutin**—Norman Hartweg.
31. **Effect of recent vulcanism on the mammal fauna of Paricutin, Mexico**—William H. Burt.
32. **Artesian springs and their relationships to animal life**—Claude W. Hibbard.
33. **The condition of vertebrate collections in Japan**—J. Linsley Gressitt.
34. **Biotic zones and provinces as distributional concepts**—E. A. Goldman.
35. **Zoological subspecies of man at the peace table**—E. Raymond Hall.

At 8 P.M. the members of both societies were the guests of the Pittsburgh Zoological Society at an informal reception and smoker in the Pittsburgh Athletic Association. A local member, MR. J. VERNER SCAIFE, JR., showed his Kodachrome movies of the Pittsburgh Zoo. Following this, the more than two hundred persons present devoted themselves assiduously to conversation and to enjoyment of the refreshments provided.

Final tabulations indicated that 85 members and 25 non-members attended, a gratifyingly large number for the first post-war meeting. A limited supply of programs, abstracts, and other literature distributed at the meeting remains on hand for distribution to members who forward large, self-addressed envelopes bearing *six cents* postage. —M. GRAHAM NETTING, *Secretary*.

1947 Meeting

AT the time of the Pittsburgh meeting, no invitations for 1947 had been received. Since then our Society and the American Society of Mammalogists have received cordial invitations to hold a rustic meeting at the Michigan Department of Conservation Training School, Higgins Lake, Michigan, in early September, or a scenic meeting in Denver at the Colorado Museum of Natural History, in late June. Each of these locations is devoid of A.S.I.H. members but has other features to recommend it. The SECRETARY has circularized the Board of Governors for a vote and the choice will be announced in the next number of COPEIA.

Research Fund

THE Revolving Research Fund continues to grow. The TREASURER has received directly or from the Fund Committee Secretary, MR. F. H. STOYE, contributions totaling $1294. It is anticipated that after members recover from vacation expenditures, gifts from additional donors will swell the Fund considerably. Applications for grants should be sent to DR. CARL L. HUBBS, Chairman of the Revolving Research Fund Committee, Box 109, La Jolla, California.

New Societies

FORMATION of the HERPETOLOGISTS LEAGUE, an organization designed to further the interests of herpetology, has been annuonced in HERPETOLOGICA, the official organ of the new League, by its founder, MAJOR CHAPMAN GRANT. Current subscribers to Herpetologica form the charter members: membership in the League is optional with any subscriber to that journal. The officers mentioned are: President, CHARLES M. BOGERT; Vice-President, HOBART M. SMITH; Editor, CHAPMAN GRANT.

The SOCIETY FOR THE STUDY OF EVOLUTION was formally organized during the March meeting of the American Association for the Advancement of Science. Founded by representatives of the fields of genetics, paleontology (vertebrate and invertebrate), taxonomy (plants and animals), ecology, and related subjects, the object of the new Society is "The promotion of the study of organic evolution and the integration of the various fields of biology interested in evolution." Included among the officers are K. P. SCHMIDT, Treasurer, and E. R. DUNN, Council Member. The annual meeting will be held in conjunction with the A.A.A.S.

The Society is open to all individuals interested in the study of evolution. Applications for membership should be sent to: Society for the Study of Evolution, care of Dr. E. Mayr, Secretary, American Museum of Natural History, New York 24, N.Y. Dues for the year 1946 were set at $1.00. The Society plans, beginning in 1947, to publish a quarterly journal and to raise the dues to include the subscription. Such a journal should be a major factor in bringing together the now widely scattered contributions to evolutionary biology.

Recent Deaths

Clement Samuel Brimley, Associate Entomologist with the North Carolina Department of Agriculture, died as he was preparing to go to his office on July 23, 1946.

Dr. Brimley was born at Great Linford, Buckingham County, England, on December 18, 1863. He later lived on a large farm in the village of Willington, 4 miles west of Bedford. Formal education was confined to seven or eight terms at the Bedford County School.

Late in 1880 farming efforts were stalemated and his father, mother, two brothers and two sisters determined to leave England for Canada or Australia. Chance brought them contact with an Immigration Agent of the North Carolina Department of Agriculture and they secured through tickets to Raleigh by way of New York and Norfolk, arriving on the last day of 1880. The night was spent in a hotel that later became the building in which he and his brother, H. H. Brimley, achieved scientific distinction.

About 1881 these brothers began collecting natural history specimens in what was an unworked field, their basic text a small book "Taxidermy Without a Teacher." H. H. Brimley started building up a State Museum in 1884. C. S. Brimley continued the supply business, and in 1919, when he joined the Entomology Division of the N. C. Department of Agriculture, scientific workers were already beating a path to his door. He was contributing many original scientific articles in the whole field of zoology that brought him recognition and admiration. Additional recognition came when in 1930 he received from the U.S. Biological Survey a 46-year certificate for bird migration studies, and in 1938 when he was awarded an honorary doctorate by the University of North Carolina.

Among his major contributions was the co-authorship of the volume, "Birds of North Carolina" in 1919 and 1942. His volume, "Insects of North Carolina," came out in 1938.

Between 1940 and 1946 he had published "Amphibians and Reptiles of North Carolina," "Mammals of North Carolina," and was co-author of "Poisonous Snakes of the Eastern United States." The latter has, in two years, been distributed to the number of 25,000 copies.

For more than 60 years, with infinite patience and perseverance, he had kept definite records, from personal observations and correspondents, of all forms of plant and animal life of his state, plus related forms from without. His series of skins and preserved specimens are a treasury that has been open to research workers. His North Carolina insect collection numbers more than a half million, of more than 7,000 species. Not the least of his accomplishments was the inspiration and material help and guidance he gave youth. Neighboring children sat entranced at his feet to hear his stories of wild creatures. Boys, girls, and adults shared the privilege of hiking afield with him. He was a generous citizen of his community and was endeared to members of his Church and fraternal organizations.

His scientific associations were kept alive by many memberships. He was a founder and honorary member of the N. C. Academy of Sciences, the N. C. Bird Club, the Raleigh Bird Club and the Raleigh Natural History Club.—Harry T. Davis, *North Carolina State Museum.*

E. G. Boulenger, son of the famous herpetologist and ichthyologist G. A. Boulenger, died on April 30, 1946, aged 57. He became Director of the Zoological Society of London Aquarium, which he had helped design, in 1923, retiring in 1943. Mr. Boulenger had a flair for presenting scientific information to the layman in palatable form, writing numerous press articles and a variety of such popular books as "Reptiles and Batrachians," "A Naturalist at the Zoo," etc. During the war of 1914–18 he was a balloon observer, and served in the late war on the General Staff in London.

DR. ULRIC DAHLGREN, Professor Emeritus of Biology at Princeton University, died May 30. Dr. Dahlgren was noted for his work on the nervous, electric and bioluminescent organs and functions of fishes.

MRS. HUGH M. SMITH died at Washington, May 3, 1946, at the age of 79 years.

Food Parcels

EARLY in 1946 it was suggested that the Society send food parcels as a token of friendship to European ichthyologists and herpetologists, whether members or not. The SECRETARY declined to circularize the entire membership for donations, but did accept proffered donations from several members. These enabled the Society to send a trade package, of sweets principally, to each of fourteen ichthyologists and herpetologists in England, Holland, Belgium, France, and Italy, as a trial. At least twelve of the packages reached their destination safely and extremely touching letters of appreciation of the Society's kindness have been received from these recipients. Many of the writers complied with the SECRETARY's request for the names and post-war addresses of surviving ichthyologists and herpetologists, and also specified the items most needed by them or in their countries.

The SECRETARY now has accurate addresses for forty-five European ichthyologists and herpetologists. Most of these individuals are receiving an adequate, but extremely uninteresting, diet; many are very short of clothing, soap, or other items. As a measure of our friendship, it would be fine to send at least an introductory trade parcel to each individual as rapidly as shipping conditions permit. The SECRETARY is most anxious, however, to fulfill specific requests in so far as time and funds permit. He will be happy to receive and expend donations from any who wish to aid their European colleagues impersonally, but he would prefer to have several dozen members write promptly, expressing their willingness to assume entire responsibility for collecting and forwarding small items needed by specific persons. In order to avoid duplication, please write to the SECRETARY for a name, specifying a particular country or person if you wish.

News Notes

THE UNIVERSITY COUNCIL OF RESEARCH of Tulane University has provided $12,350 for a five-year research program on the herpetological fauna of Louisiana, the research to be directed by ASSOCIATE PROFESSOR FRED R. CAGLE. The objectives will be to survey the herpetogical fauna of the state, to develop collections providing series adequate for defining the status of each specias, and to accumulate detailed data on reptile populations and life histories.

DR. NORMAN HARTWEG has been appointed Curator of the Division of Herpetology, Museum of Zoology, University of Michigan, to succeed HELEN T. GAIGE, who retired last September.

DR. JOSEPH R. BAILEY will join the Biology Staff of Duke University in September.

DR. NELSON MARSHALL, formerly Assistant Professor of Zoology and Fisheries Biologist at the Marine Laboratory of the University of Miami, has been appointed Associate Professor of the Department of Zoology of the University of North Carolina, at Chapel Hill.

THE NATIONAL RESEARCH COUNCIL called a Pacific Science Conference in Washington, on June 6-8, to consider and coordinate plans for American research in the Pacific. Ichthyology and Fishery Biology were represented by DR. W. M. CHAPMAN, California Academy of Sciences; DR. GEORGE S. MYERS, Stanford University; DR. CARL L. HUBBS, Scripps Institution of Oceanography; DR. FRANCES N. CLARK, California State Fisheries Laboratory; DR. H. J. DEASON, ELMER HIGGINS and O. E. SETTE of the U. S. Fish and Wildlife Service; and COMMANDER C. J. FISH, U. S. Navy. Fishery and ichthyological problems were considered under two of the divisions of the Conference, Zoology and Oceanography; and a general program of fundamental research was evolved, for which it is hoped that support may be secured. Cooperation between institutions, both private and governmental, was stressed. DR. CHAPMAN was appointed to the board of the zoological division to represent economic fisheries research, and DR. HUBBS to represent systematic ichthyology.

ALFRED S. ROMER, Curator of Vertebrate Paleontology and Director of the Biological Laboratories, Harvard University, will become Director of the Museum of Comparative Zoology on September 1. DR. HENRY B. BIGELOW has served as Acting Director of the Museum since DR. THOMAS BARBOUR'S death last January.

DR. ARNOLD GROBMAN has resigned from the University of Rochester to join the Biology Department of the University of Florida, at Gainesville.

DR. ROBERT R. MILLER, Associate Curator of Fishes in the U. S. National Museum, returned May 27, 1946, from 3 months of field work in Guatemala. He was a member of a party of three, sent at the request of the Guatemalan government by the U. S. Fish and Wildlife Service, to survey the fishery and wildlife resources of Guatemala. The assignment was supported by the program of the United States Government for scientific and cultural cooperation with the American Republics. Most of the fish collections were made in the little-explored highlands and along the Caribbean coastal plain.

DR. CARL HUBBS has sailed for a five weeks cruise on the *Zaca* with ERROL FLYNN and his father, DR. T. THOMSON FLYNN, accomplished zoologist of Queens University, Belfast. He will probably work mostly about the Revillagigedo and Clipperton Islands.

DR. W. J. K. HARKNESS is now serving as Chief of the Division of Fish and Wildlife in the Ontario Department of Lands and Forests, with which the Ontario Department of Game and Fisheries has been amalgamated. He has a two year leave from the University of Toronto.

DR. YAICHIRO OKADA, director of The Research Institute for National Resources, Hyakunincho, Yodobashi-Ku, Tokyo, writes that he is anxious to receive publications. He reports that KIYOMATSU MATSUBARA of his staff is continuing work on Japanese deep-sea fishes, with the elasmobranchs under current study. DR. KATSUZO KURONUMA is working half-time in the Institute on Japanese salmonoids and half-time with the Fisheries Section of the military government, under CAPTAIN JOHN L. KASK. The Japanese have recently established Suisan-Kagaku Kenkyosyo (The Research Institute for Fisheries).

After nearly four years, MARINE STUDIOS, at Marineland, Florida have announced the reopening of the world's only oceanarium.

HERMAN MEINKEN, 23 Bremen, Hornerstrasse 100, writes that he is well and that his house is habitable although damaged. His specimens were entirely destroyed and his library almost completely so.

FRITZ MAYER, 21 Hamburg 39, Hudtwalckertwiete 3, advises that he is well and that his home, library and aquaria are intact.

FRIEDRICH KENNEWEG, 23 Bremen 8, Glucksbergstrasse 6, lost his home and herpetological specimens. He is interested in establishing contacts in the United States for exchange of live salamanders and frogs.

A letter recently received by DR. LEONARD P. SCHULTZ from N. RIABCHIKOV, Vice-director of the Pacific Scientific Institute of Fisheries and Oceanography, Vladivostok, Russia, contains news of Russian ichthyologists. DR. A. TARANETZ was called for service in the Army at the beginning of the war. He participated in the battle for the defense of Moscow at the end of 1941 but since that time nothing has been heard from him. It is believed that he perished in the siege of that city. DR. I. I. KUZNETZOV is engaged in the study of fishes at the Office of the Local Management, Fishery Regulation (Amurrybvod), at Khabarovsk. DOCTORS L. S. BERG, G. LINDBERG, A. N. SWETOVIDOV and P. J. SCHMIDT are all quite well and working at the Zoological Museum of the U.S.S.R. at the Academy of Sciences, Leningrad. PROFESSOR A. G. KAGANOVSKY is in charge of all ichthyological work at the Pacific Institute of Fisheries and Oceanography (Vladivostok) and is anxious to exchange reprints with American ichthyologists.

Editorial Note

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